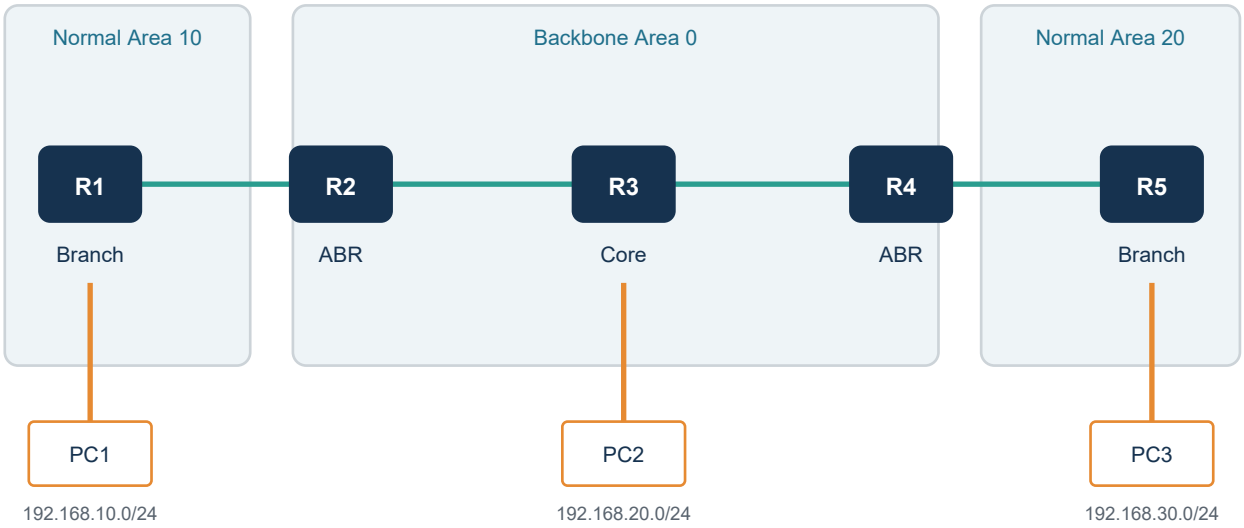
CCNP ENARSI

Lab 03

Multi-Area OSPF, ABR & Route Propagation



Guided workbook | 5 IOL L3 routers + 3 VPCS

Practice three normal areas, prove inter-area route propagation and validate the complete client path.

Blueprint	Level	Estimated time	Platform
1.10.a/b/c (selected)	Intermediate	150-180 minutes	EVE-NG / approved IOL L3

CLI annotations: GREEN - expected healthy result; YELLOW - warning or interpretation required; RED - fault or failed requirement. Colors are workbook annotations, not native CLI colors. Variable timers and ages may differ. Yellow/red items include a one-line reason.

1. Lab overview

Build a routed enterprise with Branch A in normal Area 10, an HQ backbone in Area 0 and Branch B in normal Area 20. Learn to prove the difference between full adjacency, area topology and inter-area forwarding. The outcome is an evidence-backed explanation of how two ABRs propagate remote prefixes. This is a guided IPv4 lab. Estimated time: 150-180 minutes; level: intermediate. Blueprint: 1.10.a IPv4, neighbor relationships from 1.10.b, and backbone/normal areas plus router types from 1.10.c(ii)-(iii).

2. Observable objectives

Identify R2/R4 as ABRs and backbone routers, R3 as an internal backbone router, and R1/R5 as internal non-backbone routers. Form four point-to-point links with eight FULL neighbor-table entries in total. Identify O and O IA on selected destinations; trace a Type 3 advertisement through both ABRs. Prove all six directed client paths and twenty directed loopback paths. Withdraw only Branch A reachability during a controlled disconnect, preserve HQ-to-Branch-B service, restore and regression-test.

3. Enterprise production scenario

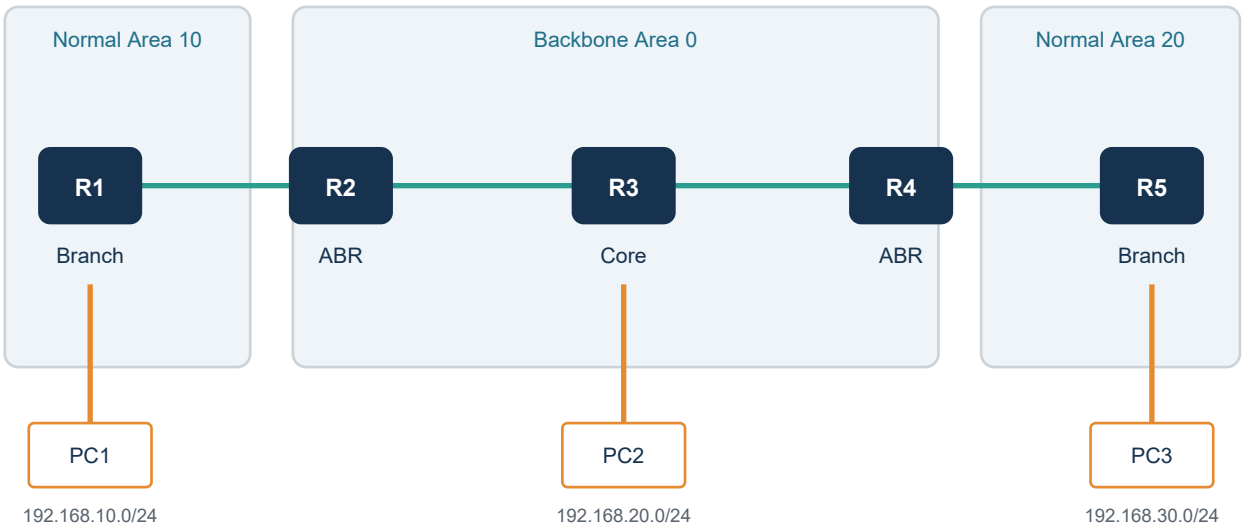
A company has two regional branches and an HQ user network. Each branch has its own OSPF area and reaches HQ through an ABR. An engineer must validate that branch advertisements cross the backbone and that a branch maintenance event has the declared impact. This small topology demonstrates area boundaries; it does not claim redundant production availability. Interview outcomes: explain ABR versus ASBR, why FULL does not prove a remote route, why an O IA prefix is not an external route, and why the far branch Router LSA is not in the local area database.

4. Required prior knowledge

Complete Lab01/Lab02 first. Know IPv4 /30 and /24 networks, interface up/up, connected/local routes, Router IDs, process IDs, FULL neighbor states, point-to-point network type, passive interfaces, and basic ping/trace. Refresher: a directly connected ping proves local forwarding; FULL proves database synchronization with that neighbor; the destination route and reverse path still need independent checks. A passive LAN advertises its subnet but sends no OSPF Hellos. OSPF process 10 is a local identifier; area IDs must agree on both ends of each transit.

5. Topology, roles and addressing

Five approved IOL L3 routers plus three VPCS. R1-R2 is Area10; R2-R3-R4 is Area0; R4-R5 is Area20. Client networks connect directly to R1, R3 and R5. R2/R4 Loopback0 is assigned to Area0. All transit costs are explicitly 10; loopback cost is explicitly 1 and LAN cost 10. These choices make metric calculations reproducible and do not model physical bandwidth.



Device role table

Device	Role	Loopback0 /32	Loopback area
R1	Internal / Branch	1.1.1.1	10
R2	ABR / Backbone	2.2.2.2	0
R3	Internal / Backbone	3.3.3.3	0
R4	ABR / Backbone	4.4.4.4	0
R5	Internal / Branch	5.5.5.5	20

Node connection table

Endpoint A	Endpoint B	Area
R1 Ethernet0/0	R2 Ethernet0/0	10
R2 Ethernet0/1	R3 Ethernet0/0	0
R3 Ethernet0/1	R4 Ethernet0/0	0
R4 Ethernet0/1	R5 Ethernet0/0	20
R1 Ethernet0/1	PC1 eth0	10
R3 Ethernet0/2	PC2 eth0	0
R5 Ethernet0/1	PC3 eth0	20

Addressing table

Link / LAN	IPv4 network	Endpoints / gateway	Area
R1-R2	10.12.12.0/30	R1: .1 / R2: .2	10
R2-R3	10.23.23.0/30	R2: .1 / R3: .2	0

Link / LAN	IPv4 network	Endpoints / gateway	Area
R3-R4	10.34.34.0/30	R3: .1 / R4: .2	0
R4-R5	10.45.45.0/30	R4: .1 / R5: .2	20
PC1 LAN	192.168.10.0/24	R1: .1 / PC1: .10	10
PC2 LAN	192.168.20.0/24	R3: .1 / PC2: .10	0
PC3 LAN	192.168.30.0/24	R5: .1 / PC3: .10	20

Every PC uses its local router .1 as the default gateway. OSPF process10 is used throughout. Transit interfaces use Ethernet0/x exactly as in the approved IOL image.

6. Choose a starting state

RAW: configure everything beginning at section8. save-ip-configuration: device names, loopbacks, transit/LAN addresses and PC names/gateways exist; verify section9 and continue at section10. It contains no router ospf or ip ospf commands. save-config: the completed healthy exercise; boot all eight nodes, allow 60 seconds after device startup for convergence, and run sections11-13 and16 without configuration entry. All three files have identical nodes, links, interfaces and coordinates.

Item	raw	save-ip-configuration	save-config
Topology	Identical	Identical	Identical
Names / IPs	Absent	Present	Present
OSPF exercise	Absent	Absent	Complete / healthy
Learner action	Build all	Build OSPF	Verify / ping

7.1 Technical deep dive: area scope and the backbone

An area is a scope for OSPF topology information. A Type1 Router LSA describes the originating router links within that area. R1 and R2 synchronize the Area10 database; that does not mean R1 also receives the complete Area20 topology. The backbone joins the two non-backbone areas through R2 and R4. Every transit in this design belongs to one area and both ends use the same area ID. R2 has an Area10 view and an Area0 view; R4 has Area0 and Area20 views. R3 belongs only to Area0. An ABR is also a backbone router here; router categories need not be mutually exclusive.

7.2 Technical deep dive: ABR, Type3 and route installation

R5 advertises its LAN as internal topology in Area20. R4 originates a Type3 Summary LSA for that prefix into Area0. R2 then originates a Type3 LSA into Area10. The Prefix can stay 192.168.30.0/24 while Advertising Router changes across the boundary. The ABR originates the advertisement for the receiving area; it does not flood the original Area20 Router LSA unchanged into Area10. R3 should learn that LAN as O IA through R4, and R1 as O IA through R2. A Type3 Summary LSA does not by itself mean multiple subnets have been manually aggregated. There is no redistribution or ASBR in this lab.

7.3 Technical deep dive: evidence, metrics and data plane

Separate the neighbor table, per-area LSDB, routing table and client forwarding. On R3, R2/R4 loopbacks are intra-area O routes; the two branch LANs are O IA. On R2, the Branch A LAN is O and Branch B LAN is O IA. An OSPF route metric combines the cost to the advertising router with its advertised destination cost. With transit cost10 and LAN cost10, R3 to BranchB LAN is expected cost30; R1 to BranchB LAN cost50. The live route table is authoritative and these predictions must be verified. An O IA route remains inside this OSPF domain and is not an external E1/E2 route. FULL on a link can coexist with an absent destination because the destination interface was not enabled in OSPF or because a separate path condition exists. A successful client ping additionally exercises gateway, route installation, forwarding and reverse routing. The branch maintenance exercise removes its transit, not a backbone link; HQ and BranchB must remain reachable. Use LSDB fields to explain behavior, then prove forwarding rather than treating an LSA as a complete service test.

8.1 Baseline R1

Set the explicit name and local addressing shown in the tables. Routers provide directly connected reachability only at this stage; client gateways are their local router LAN interfaces.

R1

```
enable
conf t
hostname R1
no ip domain lookup
interface Loopback0
description ROUTER_ID
ip address 1.1.1.1 255.255.255.255
interface Ethernet0/0
description TO_R2_AREA10
ip address 10.12.12.1 255.255.255.252
no shutdown
interface Ethernet0/1
description USER_LAN_AREA10
ip address 192.168.10.1 255.255.255.0
no shutdown
end
```

8.2 Baseline R2

Set the explicit name and local addressing shown in the tables. Routers provide directly connected reachability only at this stage; client gateways are their local router LAN interfaces.

R2

```
enable
conf t
hostname R2
no ip domain lookup
interface Loopback0
description ROUTER_ID
ip address 2.2.2.2 255.255.255.255
interface Ethernet0/0
description TO_R1_AREA10
ip address 10.12.12.2 255.255.255.252
no shutdown
interface Ethernet0/1
description TO_R3_AREA0
ip address 10.23.23.1 255.255.255.252
no shutdown
end
```

8.3 Baseline R3

Set the explicit name and local addressing shown in the tables. Routers provide directly connected reachability only at this stage; client gateways are their local router LAN interfaces.

R3

```
enable
conf t
hostname R3
no ip domain lookup
interface Loopback0
description ROUTER_ID
ip address 3.3.3.3 255.255.255.255
interface Ethernet0/0
description TO_R2_AREA0
ip address 10.23.23.2 255.255.255.252
no shutdown
interface Ethernet0/1
description TO_R4_AREA0
ip address 10.34.34.1 255.255.255.252
no shutdown
interface Ethernet0/2
description USER_LAN_AREA0
ip address 192.168.20.1 255.255.255.0
no shutdown
end
```

8.4 Baseline R4

Set the explicit name and local addressing shown in the tables. Routers provide directly connected reachability only at this stage; client gateways are their local router LAN interfaces.

R4

```
enable
conf t
hostname R4
no ip domain lookup
interface Loopback0
description ROUTER_ID
ip address 4.4.4.4 255.255.255.255
interface Ethernet0/0
description TO_R3_AREA0
ip address 10.34.34.2 255.255.255.252
no shutdown
interface Ethernet0/1
description TO_R5_AREA20
ip address 10.45.45.1 255.255.255.252
no shutdown
end
```

8.5 Baseline R5

Set the explicit name and local addressing shown in the tables. Routers provide directly connected reachability only at this stage; client gateways are their local router LAN interfaces.

R5

```
enable
conf t
hostname R5
no ip domain lookup
interface Loopback0
description ROUTER_ID
ip address 5.5.5.5 255.255.255.255
interface Ethernet0/0
description TO_R4_AREA20
ip address 10.45.45.2 255.255.255.252
no shutdown
interface Ethernet0/1
description USER_LAN_AREA20
ip address 192.168.30.1 255.255.255.0
no shutdown
end
```

8.6 Baseline PC1

Set the explicit name and local addressing shown in the tables. Routers provide directly connected reachability only at this stage; client gateways are their local router LAN interfaces.

PC1

```
set pcname PC1
ip 192.168.10.10 192.168.10.1 24
save
```

8.7 Baseline PC2

Set the explicit name and local addressing shown in the tables. Routers provide directly connected reachability only at this stage; client gateways are their local router LAN interfaces.

PC2

```
set pcname PC2
ip 192.168.20.10 192.168.20.1 24
save
```

8.8 Baseline PC3

Set the explicit name and local addressing shown in the tables. Routers provide directly connected reachability only at this stage; client gateways are their local router LAN interfaces.

PC3

```
set pcname PC3
ip 192.168.30.10 192.168.30.1 24
save
```

9.1 Verify local addressing R1

Require up/up on all used interfaces, no OSPF process, and a repeated 5/5 ping to every directly connected peer. An initial local probe may need ARP resolution; repeat before proceeding.

R1

```
enable
terminal length 0
show ip interface brief
show running-config | section router ospf
ping 10.12.12.2
ping 10.12.12.2
```

Actual CLI output - R1

```
R1# show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0/0            10.12.12.1      YES manual up                    up
Ethernet0/1            192.168.10.1    YES manual up                    up
Ethernet0/2            unassigned      YES unset  administratively down down
Ethernet0/3            unassigned      YES unset  administratively down down
Loopback0              1.1.1.1         YES manual up                    up
```

Actual CLI output - R1

```
R1# show running-config | section router ospf
```

Actual CLI output - R1

```
R1# ping 10.12.12.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.12.12.2, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 1/1/2 ms
```

WARNING - Some initial probes were lost; repeat the test and require the subsequent five replies before continuing.

Actual CLI output - R1

```
R1# ping 10.12.12.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.12.12.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

9.2 Verify local addressing R2

Require up/up on all used interfaces, no OSPF process, and a repeated 5/5 ping to every directly connected peer. An initial local probe may need ARP resolution; repeat before proceeding.

R2

```
enable
terminal length 0
show ip interface brief
show running-config | section router ospf
ping 10.12.12.1
ping 10.12.12.1
ping 10.23.23.2
ping 10.23.23.2
```

Actual CLI output - R2

```
R2# show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0/0            10.12.12.2      YES manual up                    up
Ethernet0/1            10.23.23.1      YES manual up                    up
Ethernet0/2            unassigned      YES unset  administratively down down
Ethernet0/3            unassigned      YES unset  administratively down down
Loopback0              2.2.2.2         YES manual up                    up
```

Actual CLI output - R2

```
R2# show running-config | section router ospf
```

Actual CLI output - R2

```
R2# ping 10.12.12.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.12.12.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Actual CLI output - R2

```
R2# ping 10.12.12.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.12.12.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Actual CLI output - R2

```
R2# ping 10.23.23.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.23.23.2, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 1/1/1 ms
```

WARNING - Some initial probes were lost; repeat the test and require the subsequent five replies before continuing.

Actual CLI output - R2

```
R2# ping 10.23.23.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.23.23.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

9.3 Verify local addressing R3

Require up/up on all used interfaces, no OSPF process, and a repeated 5/5 ping to every directly connected peer. An initial local probe may need ARP resolution; repeat before proceeding.

R3

```
enable
terminal length 0
show ip interface brief
show running-config | section router ospf
ping 10.23.23.1
ping 10.23.23.1
ping 10.34.34.2
ping 10.34.34.2
```

Actual CLI output - R3

```
R3# show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0/0            10.23.23.2      YES manual up                    up
Ethernet0/1            10.34.34.1      YES manual up                    up
Ethernet0/2            192.168.20.1    YES manual up                    up
Ethernet0/3            unassigned      YES unset  administratively down down
Loopback0              3.3.3.3         YES manual up                    up
```

Actual CLI output - R3

```
R3# show running-config | section router ospf
```

Actual CLI output - R3

```
R3# ping 10.23.23.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.23.23.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Actual CLI output - R3

```
R3# ping 10.23.23.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.23.23.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Actual CLI output - R3

```
R3# ping 10.34.34.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.34.34.2, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 1/1/1 ms
```

WARNING - Some initial probes were lost; repeat the test and require the subsequent five replies before continuing.

Actual CLI output - R3

```
R3# ping 10.34.34.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.34.34.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

9.4 Verify local addressing R4

Require up/up on all used interfaces, no OSPF process, and a repeated 5/5 ping to every directly connected peer. An initial local probe may need ARP resolution; repeat before proceeding.

R4

```
enable
terminal length 0
show ip interface brief
show running-config | section router ospf
ping 10.34.34.1
ping 10.34.34.1
ping 10.45.45.2
ping 10.45.45.2
```

Actual CLI output - R4

```
R4# show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0/0            10.34.34.2      YES manual up                    up
Ethernet0/1            10.45.45.1      YES manual up                    up
Ethernet0/2            unassigned      YES unset  administratively down down
Ethernet0/3            unassigned      YES unset  administratively down down
Loopback0              4.4.4.4         YES manual up                    up
```

Actual CLI output - R4

```
R4# show running-config | section router ospf
```

Actual CLI output - R4

```
R4# ping 10.34.34.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.34.34.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Actual CLI output - R4

```
R4# ping 10.34.34.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.34.34.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

Actual CLI output - R4

```
R4# ping 10.45.45.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.45.45.2, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 1/1/2 ms
```

WARNING - Some initial probes were lost; repeat the test and require the subsequent five replies before continuing.

Actual CLI output - R4

```
R4# ping 10.45.45.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.45.45.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

9.5 Verify local addressing R5

Require up/up on all used interfaces, no OSPF process, and a repeated 5/5 ping to every directly connected peer. An initial local probe may need ARP resolution; repeat before proceeding.

R5

```
enable
terminal length 0
show ip interface brief
show running-config | section router ospf
ping 10.45.45.1
ping 10.45.45.1
```

Actual CLI output - R5

```
R5# show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0/0            10.45.45.2      YES manual up                    up
Ethernet0/1            192.168.30.1    YES manual up                    up
Ethernet0/2            unassigned      YES unset  administratively down down
Ethernet0/3            unassigned      YES unset  administratively down down
Loopback0              5.5.5.5         YES manual up                    up
```

Actual CLI output - R5

```
R5# show running-config | section router ospf
```

Actual CLI output - R5

```
R5# ping 10.45.45.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.45.45.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Actual CLI output - R5

```
R5# ping 10.45.45.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.45.45.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

9.6 Verify PC1 addressing

Check NAME, IP/MASK and GATEWAY against the table. The local gateway must answer. Before OSPF exists, a remote client ping is expected to fail.

PC1

```
show ip
ping 192.168.10.1
ping 192.168.10.1
ping 192.168.30.10
```

Actual CLI output - PC1

```
PC1> show ip
NAME        : PC1[1]
IP/MASK     : 192.168.10.10/24
GATEWAY     : 192.168.10.1
MAC         : 00:50:79:66:68:06
LPORT       : 20000
RHOST:PORT  : 127.0.0.1:30000
MTU         : 1500
```

Actual CLI output - PC1

```
PC1> ping 192.168.10.1
192.168.10.1 icmp_seq=1 timeout
84 bytes from 192.168.10.1 icmp_seq=2 ttl=255 time=0.682 ms
84 bytes from 192.168.10.1 icmp_seq=3 ttl=255 time=0.604 ms
84 bytes from 192.168.10.1 icmp_seq=4 ttl=255 time=0.676 ms
84 bytes from 192.168.10.1 icmp_seq=5 ttl=255 time=0.540 ms
```

WARNING - Initial local probes may precede neighbor resolution; repeat and require five replies.

Actual CLI output - PC1

```
PC1> ping 192.168.10.1
84 bytes from 192.168.10.1 icmp_seq=1 ttl=255 time=0.469 ms
84 bytes from 192.168.10.1 icmp_seq=2 ttl=255 time=0.531 ms
84 bytes from 192.168.10.1 icmp_seq=3 ttl=255 time=0.438 ms
84 bytes from 192.168.10.1 icmp_seq=4 ttl=255 time=0.647 ms
84 bytes from 192.168.10.1 icmp_seq=5 ttl=255 time=0.690 ms
```

Actual CLI output - PC1

```
PC1> ping 192.168.30.10
*192.168.10.1 icmp_seq=1 ttl=255 time=0.509 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.10.1 icmp_seq=2 ttl=255 time=0.803 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.10.1 icmp_seq=3 ttl=255 time=1.051 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.10.1 icmp_seq=4 ttl=255 time=0.558 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.10.1 icmp_seq=5 ttl=255 time=0.582 ms (ICMP type:3, code:1, Destination host unreachable)
```

WARNING - Remote forwarding is intentionally unavailable because the routing exercise is not configured yet.

9.7 Verify PC2 addressing

Check NAME, IP/MASK and GATEWAY against the table. The local gateway must answer. Before OSPF exists, a remote client ping is expected to fail.

PC2

```
show ip
ping 192.168.20.1
ping 192.168.20.1
ping 192.168.30.10
```

Actual CLI output - PC2

```
PC2> show ip
NAME        : PC2[1]
IP/MASK     : 192.168.20.10/24
GATEWAY     : 192.168.20.1
MAC         : 00:50:79:66:68:07
LPORT       : 20000
RHOST:PORT  : 127.0.0.1:30000
MTU         : 1500
```

Actual CLI output - PC2

```
PC2> ping 192.168.20.1
192.168.20.1 icmp_seq=1 timeout
84 bytes from 192.168.20.1 icmp_seq=2 ttl=255 time=0.606 ms
84 bytes from 192.168.20.1 icmp_seq=3 ttl=255 time=0.858 ms
84 bytes from 192.168.20.1 icmp_seq=4 ttl=255 time=0.988 ms
84 bytes from 192.168.20.1 icmp_seq=5 ttl=255 time=0.908 ms
```

WARNING - Initial local probes may precede neighbor resolution; repeat and require five replies.

Actual CLI output - PC2

```
PC2> ping 192.168.20.1
84 bytes from 192.168.20.1 icmp_seq=1 ttl=255 time=0.515 ms
84 bytes from 192.168.20.1 icmp_seq=2 ttl=255 time=0.473 ms
84 bytes from 192.168.20.1 icmp_seq=3 ttl=255 time=0.527 ms
84 bytes from 192.168.20.1 icmp_seq=4 ttl=255 time=0.611 ms
84 bytes from 192.168.20.1 icmp_seq=5 ttl=255 time=0.512 ms
```

Actual CLI output - PC2

```
PC2> ping 192.168.30.10
*192.168.20.1 icmp_seq=1 ttl=255 time=1.162 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.20.1 icmp_seq=2 ttl=255 time=0.895 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.20.1 icmp_seq=3 ttl=255 time=1.132 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.20.1 icmp_seq=4 ttl=255 time=0.885 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.20.1 icmp_seq=5 ttl=255 time=1.132 ms (ICMP type:3, code:1, Destination host unreachable)
```

WARNING - Remote forwarding is intentionally unavailable because the routing exercise is not configured yet.

9.8 Verify PC3 addressing

Check NAME, IP/MASK and GATEWAY against the table. The local gateway must answer. Before OSPF exists, a remote client ping is expected to fail.

PC3

```
show ip
ping 192.168.30.1
ping 192.168.30.1
ping 192.168.10.10
```

Actual CLI output - PC3

```
PC3> show ip
NAME        : PC3[1]
IP/MASK     : 192.168.30.10/24
GATEWAY     : 192.168.30.1
MAC         : 00:50:79:66:68:08
LPORT       : 20000
RHOST:PORT  : 127.0.0.1:30000
MTU         : 1500
```

Actual CLI output - PC3

```
PC3> ping 192.168.30.1
192.168.30.1 icmp_seq=1 timeout
84 bytes from 192.168.30.1 icmp_seq=2 ttl=255 time=0.697 ms
84 bytes from 192.168.30.1 icmp_seq=3 ttl=255 time=0.750 ms
84 bytes from 192.168.30.1 icmp_seq=4 ttl=255 time=0.458 ms
84 bytes from 192.168.30.1 icmp_seq=5 ttl=255 time=0.596 ms
```

WARNING - Initial local probes may precede neighbor resolution; repeat and require five replies.

Actual CLI output - PC3

```
PC3> ping 192.168.30.1
84 bytes from 192.168.30.1 icmp_seq=1 ttl=255 time=0.605 ms
84 bytes from 192.168.30.1 icmp_seq=2 ttl=255 time=0.736 ms
84 bytes from 192.168.30.1 icmp_seq=3 ttl=255 time=0.509 ms
84 bytes from 192.168.30.1 icmp_seq=4 ttl=255 time=0.756 ms
84 bytes from 192.168.30.1 icmp_seq=5 ttl=255 time=0.508 ms
```

Actual CLI output - PC3

```
PC3> ping 192.168.10.10
*192.168.30.1 icmp_seq=1 ttl=255 time=0.625 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.30.1 icmp_seq=2 ttl=255 time=0.503 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.30.1 icmp_seq=3 ttl=255 time=0.879 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.30.1 icmp_seq=4 ttl=255 time=0.893 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.30.1 icmp_seq=5 ttl=255 time=0.445 ms (ICMP type:3, code:1, Destination host unreachable)
```

WARNING - Remote forwarding is intentionally unavailable because the routing exercise is not configured yet.

10.1 Enable OSPF on R2

Create process10 with a stable Router ID and passive-by-default policy. Approve only real router transits for Hellos. Enable each interface in the area from the table and set explicit costs. Configure the backbone first, then the two branches. Check the complete neighbor/route state in section11 after all peers are configured.

R2

```
enable
conf t
router ospf 10
router-id 2.2.2.2
passive-interface default
no passive-interface Ethernet0/0
no passive-interface Ethernet0/1
exit
interface Loopback0
ip ospf cost 1
ip ospf 10 area 0
interface Ethernet0/0
ip ospf network point-to-point
ip ospf cost 10
ip ospf 10 area 10
interface Ethernet0/1
ip ospf network point-to-point
ip ospf cost 10
ip ospf 10 area 0
end
```

10.2 Enable OSPF on R3

Create process10 with a stable Router ID and passive-by-default policy. Approve only real router transits for Hellos. Enable each interface in the area from the table and set explicit costs. Configure the backbone first, then the two branches. Check the complete neighbor/route state in section11 after all peers are configured.

R3

```
enable
conf t
router ospf 10
router-id 3.3.3.3
passive-interface default
no passive-interface Ethernet0/0
no passive-interface Ethernet0/1
exit
interface Loopback0
ip ospf cost 1
ip ospf 10 area 0
interface Ethernet0/0
ip ospf network point-to-point
ip ospf cost 10
ip ospf 10 area 0
interface Ethernet0/1
ip ospf network point-to-point
ip ospf cost 10
ip ospf 10 area 0
interface Ethernet0/2
ip ospf cost 10
ip ospf 10 area 0
end
```

10.3 Enable OSPF on R4

Create process10 with a stable Router ID and passive-by-default policy. Approve only real router transits for Hellos. Enable each interface in the area from the table and set explicit costs. Configure the backbone first, then the two branches. Check the complete neighbor/route state in section11 after all peers are configured.

R4

```
enable
conf t
router ospf 10
router-id 4.4.4.4
passive-interface default
no passive-interface Ethernet0/0
no passive-interface Ethernet0/1
exit
interface Loopback0
ip ospf cost 1
ip ospf 10 area 0
interface Ethernet0/0
ip ospf network point-to-point
ip ospf cost 10
ip ospf 10 area 0
interface Ethernet0/1
ip ospf network point-to-point
ip ospf cost 10
ip ospf 10 area 20
end
```

10.4 Enable OSPF on R1

Create process10 with a stable Router ID and passive-by-default policy. Approve only real router transits for Hellos. Enable each interface in the area from the table and set explicit costs. Configure the backbone first, then the two branches. Check the complete neighbor/route state in section11 after all peers are configured.

R1

```
enable
conf t
router ospf 10
router-id 1.1.1.1
passive-interface default
no passive-interface Ethernet0/0
exit
interface Loopback0
ip ospf cost 1
ip ospf 10 area 10
interface Ethernet0/0
ip ospf network point-to-point
ip ospf cost 10
ip ospf 10 area 10
interface Ethernet0/1
ip ospf cost 10
ip ospf 10 area 10
end
```

10.5 Enable OSPF on R5

Create process10 with a stable Router ID and passive-by-default policy. Approve only real router transits for Hellos. Enable each interface in the area from the table and set explicit costs. Configure the backbone first, then the two branches. Check the complete neighbor/route state in section11 after all peers are configured.

R5

```
enable
conf t
router ospf 10
router-id 5.5.5.5
passive-interface default
no passive-interface Ethernet0/0
exit
interface Loopback0
ip ospf cost 1
ip ospf 10 area 20
interface Ethernet0/0
ip ospf network point-to-point
ip ospf cost 10
ip ospf 10 area 20
interface Ethernet0/1
ip ospf cost 10
ip ospf 10 area 20
end
```

Wait at least 60 seconds, then verify the required state.

11.1 Verify OSPF role and neighbors R1

Read Router ID, number of areas, ABR indication, interface area/type/cost and FULL neighbor identities. Expected neighbor counts: R1=1, R2=2, R3=2, R4=2, R5=1. Transit network type must be POINT_TO_POINT. Passive entries may include unused interfaces; no required router transit may be passive.

R1

```
enable
terminal length 0
show ip ospf
show ip ospf interface brief
show ip ospf neighbor
show ip protocols
```

Actual CLI output - R1

```
R1# show ip ospf
 Routing Process "ospf 10" with ID 1.1.1.1
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 Number of areas transit capable is 0
    Area 10
        Number of interfaces in this area is 3 (1 loopback)
Area has no authentication
SPF algorithm last executed 00:00:22.116 ago
SPF algorithm executed 5 times
Area ranges are
Number of LSA 11. Checksum Sum 0x066070
```

Actual CLI output - R1

```
R1# show ip ospf interface brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Lo0          10    10              1.1.1.1/32         1     LOOP  0/0
Et0/1        10    10              192.168.10.1/24    10    DR    0/0
Et0/0        10    10              10.12.12.1/30      10    P2P   1/1
```

Actual CLI output - R1

```
R1# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
2.2.2.2           0   FULL/  -        00:00:36    10.12.12.2      Ethernet0/0
```

Actual CLI output - R1

```
R1# show ip protocols
Routing Protocol is "ospf 10"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 1.1.1.1
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
  Routing on Interfaces Configured Explicitly (Area 10):
    Loopback0
    Ethernet0/1
    Ethernet0/0
  Passive Interface(s):
    Ethernet0/1
    Ethernet0/2
    Ethernet0/3
    Loopback0
    SR0
  Routing Information Sources:
    Gateway         Distance      Last Update
    2.2.2.2              110      00:01:00
  Distance: (default is 110)
```

WARNING - Passive suppresses Hellos; exclude every transit that must form a router adjacency.

11.2 Verify OSPF role and neighbors R2

Read Router ID, number of areas, ABR indication, interface area/type/cost and FULL neighbor identities. Expected neighbor counts: R1=1, R2=2, R3=2, R4=2, R5=1. Transit network type must be POINT_TO_POINT. Passive entries may include unused interfaces; no required router transit may be passive.

R2

```
enable
terminal length 0
show ip ospf
show ip ospf interface brief
show ip ospf neighbor
show ip protocols
```

Actual CLI output - R2

```
R2# show ip ospf
 Routing Process "ospf 10" with ID 2.2.2.2
 It is an area border router
 Number of areas in this router is 2. 2 normal 0 stub 0 nssa
 Number of areas transit capable is 0
    Area BACKBONE(0)
        Number of interfaces in this area is 2 (1 loopback)
Area has no authentication
SPF algorithm last executed 00:01:04.297 ago
SPF algorithm executed 8 times
Area ranges are
Number of LSA 9. Checksum Sum 0x05E3D1
    Area 10
        Number of interfaces in this area is 1
Area has no authentication
SPF algorithm last executed 00:01:01.095 ago
SPF algorithm executed 2 times
Area ranges are
Number of LSA 11. Checksum Sum 0x066070
```

Actual CLI output - R2

```
R2# show ip ospf interface brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Lo0          10    0               2.2.2.2/32         1     LOOP  0/0
Et0/1        10    0               10.23.23.1/30      10    P2P   1/1
Et0/0        10    10              10.12.12.2/30      10    P2P   1/1
```

Actual CLI output - R2

```
R2# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
3.3.3.3           0   FULL/  -        00:00:39    10.23.23.2      Ethernet0/1
1.1.1.1           0   FULL/  -        00:00:34    10.12.12.1      Ethernet0/0
```

Actual CLI output - R2

```
R2# show ip protocols
Routing Protocol is "ospf 10"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 2.2.2.2
  It is an area border router
  Number of areas in this router is 2. 2 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
  Routing on Interfaces Configured Explicitly (Area 0):
    Loopback0
    Ethernet0/1
  Routing on Interfaces Configured Explicitly (Area 10):
    Ethernet0/0
  Passive Interface(s):
    Ethernet0/2
    Ethernet0/3
    Loopback0
    SR0
  Routing Information Sources:
    Gateway         Distance      Last Update
    1.1.1.1              110      00:01:01
    4.4.4.4              110      00:01:01
    3.3.3.3              110      00:01:06
  Distance: (default is 110)
```

WARNING - Passive suppresses Hellos; exclude every transit that must form a router adjacency.

11.3 Verify OSPF role and neighbors R3

Read Router ID, number of areas, ABR indication, interface area/type/cost and FULL neighbor identities. Expected neighbor counts: R1=1, R2=2, R3=2, R4=2, R5=1. Transit network type must be POINT_TO_POINT. Passive entries may include unused interfaces; no required router transit may be passive.

R3

```
enable
terminal length 0
show ip ospf
show ip ospf interface brief
show ip ospf neighbor
show ip protocols
```

Actual CLI output - R3

```
R3# show ip ospf
 Routing Process "ospf 10" with ID 3.3.3.3
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 Number of areas transit capable is 0
    Area BACKBONE(0)
        Number of interfaces in this area is 4 (1 loopback)
Area has no authentication
SPF algorithm last executed 00:00:27.162 ago
SPF algorithm executed 7 times
Area ranges are
Number of LSA 9. Checksum Sum 0x05E3D1
```

Actual CLI output - R3

```
R3# show ip ospf interface brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Lo0          10    0               3.3.3.3/32         1     LOOP  0/0
Et0/2        10    0               192.168.20.1/24    10    DR    0/0
Et0/1        10    0               10.34.34.1/30      10    P2P   1/1
Et0/0        10    0               10.23.23.2/30      10    P2P   1/1
```

Actual CLI output - R3

```
R3# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
4.4.4.4           0   FULL/  -        00:00:31    10.34.34.2      Ethernet0/1
2.2.2.2           0   FULL/  -        00:00:38    10.23.23.1      Ethernet0/0
```

Actual CLI output - R3

```
R3# show ip protocols
Routing Protocol is "ospf 10"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 3.3.3.3
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
  Routing on Interfaces Configured Explicitly (Area 0):
    Loopback0
    Ethernet0/2
    Ethernet0/1
    Ethernet0/0
  Passive Interface(s):
    Ethernet0/2
    Ethernet0/3
    Loopback0
    SR0
  Routing Information Sources:
    Gateway         Distance      Last Update
    4.4.4.4              110      00:01:01
    2.2.2.2              110      00:01:02
  Distance: (default is 110)
```

WARNING - Passive suppresses Hellos; exclude every transit that must form a router adjacency.

11.4 Verify OSPF role and neighbors R4

Read Router ID, number of areas, ABR indication, interface area/type/cost and FULL neighbor identities. Expected neighbor counts: R1=1, R2=2, R3=2, R4=2, R5=1. Transit network type must be POINT_TO_POINT. Passive entries may include unused interfaces; no required router transit may be passive.

R4

```
enable
terminal length 0
show ip ospf
show ip ospf interface brief
show ip ospf neighbor
show ip protocols
```

Actual CLI output - R4

```
R4# show ip ospf
 Routing Process "ospf 10" with ID 4.4.4.4
 It is an area border router
 Number of areas in this router is 2. 2 normal 0 stub 0 nssa
 Number of areas transit capable is 0
    Area BACKBONE(0)
        Number of interfaces in this area is 2 (1 loopback)
Area has no authentication
SPF algorithm last executed 00:01:05.862 ago
SPF algorithm executed 4 times
Area ranges are
Number of LSA 9. Checksum Sum 0x05E3D1
    Area 20
        Number of interfaces in this area is 1
Area has no authentication
SPF algorithm last executed 00:01:02.132 ago
SPF algorithm executed 3 times
Area ranges are
Number of LSA 11. Checksum Sum 0x055F1C
```

Actual CLI output - R4

```
R4# show ip ospf interface brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Lo0          10    0               4.4.4.4/32         1     LOOP  0/0
Et0/0        10    0               10.34.34.2/30      10    P2P   1/1
Et0/1        10    20              10.45.45.1/30      10    P2P   1/1
```

Actual CLI output - R4

```
R4# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
3.3.3.3           0   FULL/  -        00:00:37    10.34.34.1      Ethernet0/0
5.5.5.5           0   FULL/  -        00:00:33    10.45.45.2      Ethernet0/1
```

Actual CLI output - R4

```
R4# show ip protocols
Routing Protocol is "ospf 10"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 4.4.4.4
  It is an area border router
  Number of areas in this router is 2. 2 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
  Routing on Interfaces Configured Explicitly (Area 0):
    Loopback0
    Ethernet0/0
  Routing on Interfaces Configured Explicitly (Area 20):
    Ethernet0/1
  Passive Interface(s):
    Ethernet0/2
    Ethernet0/3
    Loopback0
    SR0
  Routing Information Sources:
    Gateway         Distance      Last Update
    5.5.5.5              110      00:01:02
    2.2.2.2              110      00:01:02
    3.3.3.3              110      00:01:06
  Distance: (default is 110)
```

WARNING - Passive suppresses Hellos; exclude every transit that must form a router adjacency.

11.5 Verify OSPF role and neighbors R5

Read Router ID, number of areas, ABR indication, interface area/type/cost and FULL neighbor identities. Expected neighbor counts: R1=1, R2=2, R3=2, R4=2, R5=1. Transit network type must be POINT_TO_POINT. Passive entries may include unused interfaces; no required router transit may be passive.

R5

```
enable
terminal length 0
show ip ospf
show ip ospf interface brief
show ip ospf neighbor
show ip protocols
```

Actual CLI output - R5

```
R5# show ip ospf
 Routing Process "ospf 10" with ID 5.5.5.5
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 Number of areas transit capable is 0
    Area 20
        Number of interfaces in this area is 3 (1 loopback)
Area has no authentication
SPF algorithm last executed 00:00:22.745 ago
SPF algorithm executed 5 times
Area ranges are
Number of LSA 11. Checksum Sum 0x055F1C
```

Actual CLI output - R5

```
R5# show ip ospf interface brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Lo0          10    20              5.5.5.5/32         1     LOOP  0/0
Et0/1        10    20              192.168.30.1/24    10    DR    0/0
Et0/0        10    20              10.45.45.2/30      10    P2P   1/1
```

Actual CLI output - R5

```
R5# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
4.4.4.4           0   FULL/  -        00:00:30    10.45.45.1      Ethernet0/0
```

Actual CLI output - R5

```
R5# show ip protocols
Routing Protocol is "ospf 10"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 5.5.5.5
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
  Routing on Interfaces Configured Explicitly (Area 20):
    Loopback0
    Ethernet0/1
    Ethernet0/0
  Passive Interface(s):
    Ethernet0/1
    Ethernet0/2
    Ethernet0/3
    Loopback0
    SR0
  Routing Information Sources:
    Gateway         Distance      Last Update
    4.4.4.4              110      00:01:03
  Distance: (default is 110)
```

WARNING - Passive suppresses Hellos; exclude every transit that must form a router adjacency.

12.1 Trace installed routes R1

Match O versus O IA to the destination area and identify the next hop. R3 has intra-area routes to ABR loopbacks and inter-area routes to branch LANs. R2 reaches BranchA LAN intra-area and BranchB LAN inter-area. Check route detail and actual metric rather than inferring reachability from neighbors.

R1

```
enable
terminal length 0
show ip route ospf
show ip route 192.168.30.0
show ip route 192.168.10.0
```

Actual CLI output - R1

```
R1# show ip route ospf
Gateway of last resort is not set
      2.0.0.0/32 is subnetted, 1 subnets
O IA     2.2.2.2 [110/11] via 10.12.12.2, 00:01:05, Ethernet0/0
      3.0.0.0/32 is subnetted, 1 subnets
O IA     3.3.3.3 [110/21] via 10.12.12.2, 00:01:05, Ethernet0/0
      4.0.0.0/32 is subnetted, 1 subnets
O IA     4.4.4.4 [110/31] via 10.12.12.2, 00:01:05, Ethernet0/0
      5.0.0.0/32 is subnetted, 1 subnets
O IA     5.5.5.5 [110/41] via 10.12.12.2, 00:01:03, Ethernet0/0
      10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
O IA     10.23.23.0/30 [110/20] via 10.12.12.2, 00:01:05, Ethernet0/0
O IA     10.34.34.0/30 [110/30] via 10.12.12.2, 00:01:05, Ethernet0/0
O IA     10.45.45.0/30 [110/40] via 10.12.12.2, 00:01:05, Ethernet0/0
O IA  192.168.20.0/24 [110/30] via 10.12.12.2, 00:01:05, Ethernet0/0
O IA  192.168.30.0/24 [110/50] via 10.12.12.2, 00:01:03, Ethernet0/0
```

Actual CLI output - R1

```
R1# show ip route 192.168.30.0
Routing entry for 192.168.30.0/24
  Known via "ospf 10", distance 110, metric 50, type inter area
  Last update from 10.12.12.2 on Ethernet0/0, 00:01:03 ago
  Routing Descriptor Blocks:
  * 10.12.12.2, from 2.2.2.2, 00:01:03 ago, via Ethernet0/0
      Route metric is 50, traffic share count is 1
```

Actual CLI output - R1

```
R1# show ip route 192.168.10.0
Routing entry for 192.168.10.0/24, 2 known subnets
  Attached (2 connections)
  Variably subnetted with 2 masks
C        192.168.10.0/24 is directly connected, Ethernet0/1
L        192.168.10.1/32 is directly connected, Ethernet0/1
```

12.2 Trace installed routes R2

Match O versus O IA to the destination area and identify the next hop. R3 has intra-area routes to ABR loopbacks and inter-area routes to branch LANs. R2 reaches BranchA LAN intra-area and BranchB LAN inter-area. Check route detail and actual metric rather than inferring reachability from neighbors.

R2

```
enable
terminal length 0
show ip route ospf
show ip route 192.168.30.0
show ip route 192.168.10.0
```

Actual CLI output - R2

```
R2# show ip route ospf
Gateway of last resort is not set
      1.0.0.0/32 is subnetted, 1 subnets
O        1.1.1.1 [110/11] via 10.12.12.1, 00:01:04, Ethernet0/0
      3.0.0.0/32 is subnetted, 1 subnets
O        3.3.3.3 [110/11] via 10.23.23.2, 00:01:10, Ethernet0/1
      4.0.0.0/32 is subnetted, 1 subnets
O        4.4.4.4 [110/21] via 10.23.23.2, 00:01:07, Ethernet0/1
      5.0.0.0/32 is subnetted, 1 subnets
O IA     5.5.5.5 [110/31] via 10.23.23.2, 00:01:04, Ethernet0/1
      10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O        10.34.34.0/30 [110/20] via 10.23.23.2, 00:01:09, Ethernet0/1
O IA     10.45.45.0/30 [110/30] via 10.23.23.2, 00:01:07, Ethernet0/1
O     192.168.10.0/24 [110/20] via 10.12.12.1, 00:01:04, Ethernet0/0
O     192.168.20.0/24 [110/20] via 10.23.23.2, 00:01:09, Ethernet0/1
O IA  192.168.30.0/24 [110/40] via 10.23.23.2, 00:01:04, Ethernet0/1
```

Actual CLI output - R2

```
R2# show ip route 192.168.30.0
Routing entry for 192.168.30.0/24
  Known via "ospf 10", distance 110, metric 40, type inter area
  Last update from 10.23.23.2 on Ethernet0/1, 00:01:04 ago
  Routing Descriptor Blocks:
  * 10.23.23.2, from 4.4.4.4, 00:01:04 ago, via Ethernet0/1
      Route metric is 40, traffic share count is 1
```

Actual CLI output - R2

```
R2# show ip route 192.168.10.0
Routing entry for 192.168.10.0/24
  Known via "ospf 10", distance 110, metric 20, type intra area
  Last update from 10.12.12.1 on Ethernet0/0, 00:01:04 ago
  Routing Descriptor Blocks:
  * 10.12.12.1, from 1.1.1.1, 00:01:04 ago, via Ethernet0/0
      Route metric is 20, traffic share count is 1
```

12.3 Trace installed routes R3

Match O versus O IA to the destination area and identify the next hop. R3 has intra-area routes to ABR loopbacks and inter-area routes to branch LANs. R2 reaches BranchA LAN intra-area and BranchB LAN inter-area. Check route detail and actual metric rather than inferring reachability from neighbors.

R3

```
enable
terminal length 0
show ip route ospf
show ip route 192.168.30.0
show ip route 192.168.10.0
```

Actual CLI output - R3

```
R3# show ip route ospf
Gateway of last resort is not set
      1.0.0.0/32 is subnetted, 1 subnets
O IA     1.1.1.1 [110/21] via 10.23.23.1, 00:01:04, Ethernet0/0
      2.0.0.0/32 is subnetted, 1 subnets
O        2.2.2.2 [110/11] via 10.23.23.1, 00:01:10, Ethernet0/0
      4.0.0.0/32 is subnetted, 1 subnets
O        4.4.4.4 [110/11] via 10.34.34.2, 00:01:07, Ethernet0/1
      5.0.0.0/32 is subnetted, 1 subnets
O IA     5.5.5.5 [110/21] via 10.34.34.2, 00:01:04, Ethernet0/1
      10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O IA     10.12.12.0/30 [110/20] via 10.23.23.1, 00:01:10, Ethernet0/0
O IA     10.45.45.0/30 [110/20] via 10.34.34.2, 00:01:07, Ethernet0/1
O IA  192.168.10.0/24 [110/30] via 10.23.23.1, 00:01:04, Ethernet0/0
O IA  192.168.30.0/24 [110/30] via 10.34.34.2, 00:01:04, Ethernet0/1
```

Actual CLI output - R3

```
R3# show ip route 192.168.30.0
Routing entry for 192.168.30.0/24
  Known via "ospf 10", distance 110, metric 30, type inter area
  Last update from 10.34.34.2 on Ethernet0/1, 00:01:05 ago
  Routing Descriptor Blocks:
  * 10.34.34.2, from 4.4.4.4, 00:01:05 ago, via Ethernet0/1
      Route metric is 30, traffic share count is 1
```

Actual CLI output - R3

```
R3# show ip route 192.168.10.0
Routing entry for 192.168.10.0/24
  Known via "ospf 10", distance 110, metric 30, type inter area
  Last update from 10.23.23.1 on Ethernet0/0, 00:01:05 ago
  Routing Descriptor Blocks:
  * 10.23.23.1, from 2.2.2.2, 00:01:05 ago, via Ethernet0/0
      Route metric is 30, traffic share count is 1
```

12.4 Trace installed routes R4

Match O versus O IA to the destination area and identify the next hop. R3 has intra-area routes to ABR loopbacks and inter-area routes to branch LANs. R2 reaches BranchA LAN intra-area and BranchB LAN inter-area. Check route detail and actual metric rather than inferring reachability from neighbors.

R4

```
enable
terminal length 0
show ip route ospf
show ip route 192.168.30.0
show ip route 192.168.10.0
```

Actual CLI output - R4

```
R4# show ip route ospf
Gateway of last resort is not set
      1.0.0.0/32 is subnetted, 1 subnets
O IA     1.1.1.1 [110/31] via 10.34.34.1, 00:01:05, Ethernet0/0
      2.0.0.0/32 is subnetted, 1 subnets
O        2.2.2.2 [110/21] via 10.34.34.1, 00:01:09, Ethernet0/0
      3.0.0.0/32 is subnetted, 1 subnets
O        3.3.3.3 [110/11] via 10.34.34.1, 00:01:09, Ethernet0/0
      5.0.0.0/32 is subnetted, 1 subnets
O        5.5.5.5 [110/11] via 10.45.45.2, 00:01:06, Ethernet0/1
      10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O IA     10.12.12.0/30 [110/30] via 10.34.34.1, 00:01:09, Ethernet0/0
O        10.23.23.0/30 [110/20] via 10.34.34.1, 00:01:09, Ethernet0/0
O IA  192.168.10.0/24 [110/40] via 10.34.34.1, 00:01:05, Ethernet0/0
O     192.168.20.0/24 [110/20] via 10.34.34.1, 00:01:09, Ethernet0/0
O     192.168.30.0/24 [110/20] via 10.45.45.2, 00:01:05, Ethernet0/1
```

Actual CLI output - R4

```
R4# show ip route 192.168.30.0
Routing entry for 192.168.30.0/24
  Known via "ospf 10", distance 110, metric 20, type intra area
  Last update from 10.45.45.2 on Ethernet0/1, 00:01:05 ago
  Routing Descriptor Blocks:
  * 10.45.45.2, from 5.5.5.5, 00:01:05 ago, via Ethernet0/1
      Route metric is 20, traffic share count is 1
```

Actual CLI output - R4

```
R4# show ip route 192.168.10.0
Routing entry for 192.168.10.0/24
  Known via "ospf 10", distance 110, metric 40, type inter area
  Last update from 10.34.34.1 on Ethernet0/0, 00:01:05 ago
  Routing Descriptor Blocks:
  * 10.34.34.1, from 2.2.2.2, 00:01:05 ago, via Ethernet0/0
      Route metric is 40, traffic share count is 1
```

12.5 Trace installed routes R5

Match O versus O IA to the destination area and identify the next hop. R3 has intra-area routes to ABR loopbacks and inter-area routes to branch LANs. R2 reaches BranchA LAN intra-area and BranchB LAN inter-area. Check route detail and actual metric rather than inferring reachability from neighbors.

R5

```
enable
terminal length 0
show ip route ospf
show ip route 192.168.30.0
show ip route 192.168.10.0
```

Actual CLI output - R5

```
R5# show ip route ospf
Gateway of last resort is not set
      1.0.0.0/32 is subnetted, 1 subnets
O IA     1.1.1.1 [110/41] via 10.45.45.1, 00:01:06, Ethernet0/0
      2.0.0.0/32 is subnetted, 1 subnets
O IA     2.2.2.2 [110/31] via 10.45.45.1, 00:01:06, Ethernet0/0
      3.0.0.0/32 is subnetted, 1 subnets
O IA     3.3.3.3 [110/21] via 10.45.45.1, 00:01:06, Ethernet0/0
      4.0.0.0/32 is subnetted, 1 subnets
O IA     4.4.4.4 [110/11] via 10.45.45.1, 00:01:06, Ethernet0/0
      10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
O IA     10.12.12.0/30 [110/40] via 10.45.45.1, 00:01:06, Ethernet0/0
O IA     10.23.23.0/30 [110/30] via 10.45.45.1, 00:01:06, Ethernet0/0
O IA     10.34.34.0/30 [110/20] via 10.45.45.1, 00:01:06, Ethernet0/0
O IA  192.168.10.0/24 [110/50] via 10.45.45.1, 00:01:06, Ethernet0/0
O IA  192.168.20.0/24 [110/30] via 10.45.45.1, 00:01:06, Ethernet0/0
```

Actual CLI output - R5

```
R5# show ip route 192.168.30.0
Routing entry for 192.168.30.0/24, 2 known subnets
  Attached (2 connections)
  Variably subnetted with 2 masks
C        192.168.30.0/24 is directly connected, Ethernet0/1
L        192.168.30.1/32 is directly connected, Ethernet0/1
```

Actual CLI output - R5

```
R5# show ip route 192.168.10.0
Routing entry for 192.168.10.0/24
  Known via "ospf 10", distance 110, metric 50, type inter area
  Last update from 10.45.45.1 on Ethernet0/0, 00:01:06 ago
  Routing Descriptor Blocks:
  * 10.45.45.1, from 4.4.4.4, 00:01:06 ago, via Ethernet0/0
      Route metric is 50, traffic share count is 1
```

12.6 Follow per-area LSAs R1

Read the Area header, Link State ID, Advertising Router and Network Mask. In R3 Area0 the BranchB Type3 is originated by R4; in R1 Area10 it is originated by R2. R3 has no Area0 Router LSA originated by R1; that expected absence demonstrates area scope. R5 learns its own LAN internally rather than as a remote inter-area route.

R1

```
enable
terminal length 0
show ip ospf database router
show ip ospf database summary 192.168.30.0
```

Actual CLI output - R1

```
R1# show ip ospf database router
Router Link States (Area 10)
  LS age: 27
  LS Type: Router Links
  Link State ID: 1.1.1.1
  Advertising Router: 1.1.1.1
  Number of Links: 4
  LS age: 69
  LS Type: Router Links
  Link State ID: 2.2.2.2
  Advertising Router: 2.2.2.2
  Area Border Router
  Number of Links: 2
```

Actual CLI output - R1

```
R1# show ip ospf database summary 192.168.30.0
            OSPF Router with ID (1.1.1.1) (Process ID 10)
Summary Net Link States (Area 10)
  LS age: 67
  Options: (No TOS-capability, DC, Upward)
  LS Type: Summary Links(Network)
  Link State ID: 192.168.30.0 (summary Network Number)
  Advertising Router: 2.2.2.2
  LS Seq Number: 80000001
  Checksum: 0xE1A3
  Length: 28
  Network Mask: /24
MTID: 0  Metric: 40
```

12.7 Follow per-area LSAs R2

Read the Area header, Link State ID, Advertising Router and Network Mask. In R3 Area0 the BranchB Type3 is originated by R4; in R1 Area10 it is originated by R2. R3 has no Area0 Router LSA originated by R1; that expected absence demonstrates area scope. R5 learns its own LAN internally rather than as a remote inter-area route.

R2

```
enable
terminal length 0
show ip ospf database router
show ip ospf database summary 192.168.30.0
```

Actual CLI output - R2

```
R2# show ip ospf database router
Router Link States (Area 0)
  LS age: 72
  LS Type: Router Links
  Link State ID: 2.2.2.2
  Advertising Router: 2.2.2.2
  Area Border Router
  Number of Links: 3
  LS age: 33
  LS Type: Router Links
  Link State ID: 3.3.3.3
  Advertising Router: 3.3.3.3
  Number of Links: 6
  LS age: 72
  LS Type: Router Links
  Link State ID: 4.4.4.4
  Advertising Router: 4.4.4.4
  Area Border Router
  Number of Links: 3
```

Actual CLI output - R2

```
R2# show ip ospf database router
Router Link States (Area 10)
  LS age: 29
  LS Type: Router Links
  Link State ID: 1.1.1.1
  Advertising Router: 1.1.1.1
  Number of Links: 4
  LS age: 68
  LS Type: Router Links
  Link State ID: 2.2.2.2
  Advertising Router: 2.2.2.2
  Area Border Router
  Number of Links: 2
```

Actual CLI output - R2

```
R2# show ip ospf database summary 192.168.30.0
            OSPF Router with ID (2.2.2.2) (Process ID 10)
Summary Net Link States (Area 0)
  LS age: 68
  Options: (No TOS-capability, DC, Upward)
  LS Type: Summary Links(Network)
  Link State ID: 192.168.30.0 (summary Network Number)
  Advertising Router: 4.4.4.4
  LS Seq Number: 80000001
  Checksum: 0xDCB4
  Length: 28
  Network Mask: /24
MTID: 0  Metric: 20
Summary Net Link States (Area 10)
  LS age: 66
  Options: (No TOS-capability, DC, Upward)
  LS Type: Summary Links(Network)
  Link State ID: 192.168.30.0 (summary Network Number)
  Advertising Router: 2.2.2.2
  LS Seq Number: 80000001
  Checksum: 0xE1A3
  Length: 28
  Network Mask: /24
MTID: 0  Metric: 40
```

12.8 Follow per-area LSAs R3

Read the Area header, Link State ID, Advertising Router and Network Mask. In R3 Area0 the BranchB Type3 is originated by R4; in R1 Area10 it is originated by R2. R3 has no Area0 Router LSA originated by R1; that expected absence demonstrates area scope. R5 learns its own LAN internally rather than as a remote inter-area route.

R3

```
enable
terminal length 0
show ip ospf database router
show ip ospf database summary 192.168.30.0
show ip ospf database router 1.1.1.1
```

Actual CLI output - R3

```
R3# show ip ospf database router
Router Link States (Area 0)
  LS age: 74
  LS Type: Router Links
  Link State ID: 2.2.2.2
  Advertising Router: 2.2.2.2
  Area Border Router
  Number of Links: 3
  LS age: 32
  LS Type: Router Links
  Link State ID: 3.3.3.3
  Advertising Router: 3.3.3.3
  Number of Links: 6
  LS age: 71
  LS Type: Router Links
  Link State ID: 4.4.4.4
  Advertising Router: 4.4.4.4
  Area Border Router
  Number of Links: 3
```

Actual CLI output - R3

```
R3# show ip ospf database summary 192.168.30.0
            OSPF Router with ID (3.3.3.3) (Process ID 10)
Summary Net Link States (Area 0)
  LS age: 67
  Options: (No TOS-capability, DC, Upward)
  LS Type: Summary Links(Network)
  Link State ID: 192.168.30.0 (summary Network Number)
  Advertising Router: 4.4.4.4
  LS Seq Number: 80000001
  Checksum: 0xDCB4
  Length: 28
  Network Mask: /24
MTID: 0  Metric: 20
```

Actual CLI output - R3

```
R3# show ip ospf database router 1.1.1.1
            OSPF Router with ID (3.3.3.3) (Process ID 10)
```

WARNING - R1 is outside Area 0; its Router LSA is not expected in R3 Area 0.

12.9 Follow per-area LSAs R4

Read the Area header, Link State ID, Advertising Router and Network Mask. In R3 Area0 the BranchB Type3 is originated by R4; in R1 Area10 it is originated by R2. R3 has no Area0 Router LSA originated by R1; that expected absence demonstrates area scope. R5 learns its own LAN internally rather than as a remote inter-area route.

R4

```
enable
terminal length 0
show ip ospf database router
show ip ospf database summary 192.168.30.0
```

Actual CLI output - R4

```
R4# show ip ospf database router
Router Link States (Area 0)
  LS age: 75
  LS Type: Router Links
  Link State ID: 2.2.2.2
  Advertising Router: 2.2.2.2
  Area Border Router
  Number of Links: 3
  LS age: 33
  LS Type: Router Links
  Link State ID: 3.3.3.3
  Advertising Router: 3.3.3.3
  Number of Links: 6
  LS age: 70
  LS Type: Router Links
  Link State ID: 4.4.4.4
  Advertising Router: 4.4.4.4
  Area Border Router
  Number of Links: 3
```

Actual CLI output - R4

```
R4# show ip ospf database router
Router Link States (Area 20)
  LS age: 67
  LS Type: Router Links
  Link State ID: 4.4.4.4
  Advertising Router: 4.4.4.4
  Area Border Router
  Number of Links: 2
  LS age: 28
  LS Type: Router Links
  Link State ID: 5.5.5.5
  Advertising Router: 5.5.5.5
  Number of Links: 4
```

Actual CLI output - R4

```
R4# show ip ospf database summary 192.168.30.0
            OSPF Router with ID (4.4.4.4) (Process ID 10)
Summary Net Link States (Area 0)
  LS age: 67
  Options: (No TOS-capability, DC, Upward)
  LS Type: Summary Links(Network)
  Link State ID: 192.168.30.0 (summary Network Number)
  Advertising Router: 4.4.4.4
  LS Seq Number: 80000001
  Checksum: 0xDCB4
  Length: 28
  Network Mask: /24
MTID: 0  Metric: 20
```

12.10 Follow per-area LSAs R5

Read the Area header, Link State ID, Advertising Router and Network Mask. In R3 Area0 the BranchB Type3 is originated by R4; in R1 Area10 it is originated by R2. R3 has no Area0 Router LSA originated by R1; that expected absence demonstrates area scope. R5 learns its own LAN internally rather than as a remote inter-area route.

R5

```
enable
terminal length 0
show ip ospf database router
show ip ospf database summary 192.168.30.0
```

Actual CLI output - R5

```
R5# show ip ospf database router
Router Link States (Area 20)
  LS age: 69
  LS Type: Router Links
  Link State ID: 4.4.4.4
  Advertising Router: 4.4.4.4
  Area Border Router
  Number of Links: 2
  LS age: 27
  LS Type: Router Links
  Link State ID: 5.5.5.5
  Advertising Router: 5.5.5.5
  Number of Links: 4
```

Actual CLI output - R5

```
R5# show ip ospf database summary 192.168.30.0
            OSPF Router with ID (5.5.5.5) (Process ID 10)
```

13.1 End-to-end client PC1

Require five successful replies on each repeated remote-client ping. Explain the observed hop sequence. VPCS UDP trace may end with destination port-unreachable; that can indicate arrival at the intended endpoint rather than a failed ping.

PC1

```
show ip
ping 192.168.20.10
ping 192.168.20.10
ping 192.168.30.10
ping 192.168.30.10
trace 192.168.30.10
```

Actual CLI output - PC1

```
PC1> show ip
NAME        : PC1[1]
IP/MASK     : 192.168.10.10/24
GATEWAY     : 192.168.10.1
MAC         : 00:50:79:66:68:06
LPORT       : 20000
RHOST:PORT  : 127.0.0.1:30000
MTU         : 1500
```

Actual CLI output - PC1

```
PC1> ping 192.168.20.10
84 bytes from 192.168.20.10 icmp_seq=1 ttl=61 time=1.618 ms
84 bytes from 192.168.20.10 icmp_seq=2 ttl=61 time=1.611 ms
84 bytes from 192.168.20.10 icmp_seq=3 ttl=61 time=2.985 ms
84 bytes from 192.168.20.10 icmp_seq=4 ttl=61 time=1.802 ms
84 bytes from 192.168.20.10 icmp_seq=5 ttl=61 time=1.903 ms
```

Actual CLI output - PC1

```
PC1> ping 192.168.20.10
84 bytes from 192.168.20.10 icmp_seq=1 ttl=61 time=1.654 ms
84 bytes from 192.168.20.10 icmp_seq=2 ttl=61 time=4.339 ms
84 bytes from 192.168.20.10 icmp_seq=3 ttl=61 time=2.591 ms
84 bytes from 192.168.20.10 icmp_seq=4 ttl=61 time=4.172 ms
84 bytes from 192.168.20.10 icmp_seq=5 ttl=61 time=1.737 ms
```

Actual CLI output - PC1

```
PC1> ping 192.168.30.10
84 bytes from 192.168.30.10 icmp_seq=1 ttl=59 time=1.964 ms
84 bytes from 192.168.30.10 icmp_seq=2 ttl=59 time=2.696 ms
84 bytes from 192.168.30.10 icmp_seq=3 ttl=59 time=2.368 ms
84 bytes from 192.168.30.10 icmp_seq=4 ttl=59 time=2.330 ms
84 bytes from 192.168.30.10 icmp_seq=5 ttl=59 time=2.126 ms
```

Actual CLI output - PC1

```
PC1> ping 192.168.30.10
84 bytes from 192.168.30.10 icmp_seq=1 ttl=59 time=3.226 ms
84 bytes from 192.168.30.10 icmp_seq=2 ttl=59 time=2.677 ms
84 bytes from 192.168.30.10 icmp_seq=3 ttl=59 time=2.061 ms
84 bytes from 192.168.30.10 icmp_seq=4 ttl=59 time=4.297 ms
84 bytes from 192.168.30.10 icmp_seq=5 ttl=59 time=2.819 ms
```

Actual CLI output - PC1

```
PC1> trace 192.168.30.10
trace to 192.168.30.10, 8 hops max, press Ctrl+C to stop
 1   192.168.10.1   0.511 ms  0.409 ms  0.443 ms
 2   10.12.12.2   1.216 ms  0.814 ms  0.752 ms
 3   10.23.23.2   1.065 ms  0.805 ms  0.929 ms
 4   10.34.34.2   1.471 ms  1.752 ms  1.821 ms
 5   10.45.45.2   1.823 ms  1.601 ms  1.600 ms
 6   *192.168.30.10   1.644 ms (ICMP type:3, code:3, Destination port unreachable)
```

WARNING - VPCS replies with UDP port-unreachable at the destination; this normally ends the trace.

13.2 End-to-end client PC2

Require five successful replies on each repeated remote-client ping. Explain the observed hop sequence. VPCS UDP trace may end with destination port-unreachable; that can indicate arrival at the intended endpoint rather than a failed ping.

PC2

```
show ip
ping 192.168.10.10
ping 192.168.10.10
ping 192.168.30.10
ping 192.168.30.10
trace 192.168.30.10
```

Actual CLI output - PC2

```
PC2> show ip
NAME        : PC2[1]
IP/MASK     : 192.168.20.10/24
GATEWAY     : 192.168.20.1
MAC         : 00:50:79:66:68:07
LPORT       : 20000
RHOST:PORT  : 127.0.0.1:30000
MTU         : 1500
```

Actual CLI output - PC2

```
PC2> ping 192.168.10.10
84 bytes from 192.168.10.10 icmp_seq=1 ttl=61 time=1.646 ms
84 bytes from 192.168.10.10 icmp_seq=2 ttl=61 time=1.502 ms
84 bytes from 192.168.10.10 icmp_seq=3 ttl=61 time=1.547 ms
84 bytes from 192.168.10.10 icmp_seq=4 ttl=61 time=1.532 ms
84 bytes from 192.168.10.10 icmp_seq=5 ttl=61 time=10.601 ms
```

Actual CLI output - PC2

```
PC2> ping 192.168.10.10
84 bytes from 192.168.10.10 icmp_seq=1 ttl=61 time=3.443 ms
84 bytes from 192.168.10.10 icmp_seq=2 ttl=61 time=1.308 ms
84 bytes from 192.168.10.10 icmp_seq=3 ttl=61 time=1.595 ms
84 bytes from 192.168.10.10 icmp_seq=4 ttl=61 time=1.418 ms
84 bytes from 192.168.10.10 icmp_seq=5 ttl=61 time=2.863 ms
```

Actual CLI output - PC2

```
PC2> ping 192.168.30.10
84 bytes from 192.168.30.10 icmp_seq=1 ttl=61 time=2.668 ms
84 bytes from 192.168.30.10 icmp_seq=2 ttl=61 time=1.737 ms
84 bytes from 192.168.30.10 icmp_seq=3 ttl=61 time=1.437 ms
84 bytes from 192.168.30.10 icmp_seq=4 ttl=61 time=5.571 ms
84 bytes from 192.168.30.10 icmp_seq=5 ttl=61 time=4.696 ms
```

Actual CLI output - PC2

```
PC2> ping 192.168.30.10
84 bytes from 192.168.30.10 icmp_seq=1 ttl=61 time=1.368 ms
84 bytes from 192.168.30.10 icmp_seq=2 ttl=61 time=1.369 ms
84 bytes from 192.168.30.10 icmp_seq=3 ttl=61 time=1.474 ms
84 bytes from 192.168.30.10 icmp_seq=4 ttl=61 time=2.305 ms
84 bytes from 192.168.30.10 icmp_seq=5 ttl=61 time=2.441 ms
```

Actual CLI output - PC2

```
PC2> trace 192.168.30.10
trace to 192.168.30.10, 8 hops max, press Ctrl+C to stop
 1   192.168.20.1   0.727 ms  0.709 ms  0.659 ms
 2   10.34.34.2   1.583 ms  1.465 ms  1.170 ms
 3   10.45.45.2   2.078 ms  2.862 ms  2.397 ms
 4   *192.168.30.10   2.326 ms (ICMP type:3, code:3, Destination port unreachable)
```

WARNING - VPCS replies with UDP port-unreachable at the destination; this normally ends the trace.

13.3 End-to-end client PC3

Require five successful replies on each repeated remote-client ping. Explain the observed hop sequence. VPCS UDP trace may end with destination port-unreachable; that can indicate arrival at the intended endpoint rather than a failed ping.

PC3

```
show ip
ping 192.168.10.10
ping 192.168.10.10
ping 192.168.20.10
ping 192.168.20.10
trace 192.168.10.10
```

Actual CLI output - PC3

```
PC3> show ip
NAME        : PC3[1]
IP/MASK     : 192.168.30.10/24
GATEWAY     : 192.168.30.1
MAC         : 00:50:79:66:68:08
LPORT       : 20000
RHOST:PORT  : 127.0.0.1:30000
MTU         : 1500
```

Actual CLI output - PC3

```
PC3> ping 192.168.10.10
84 bytes from 192.168.10.10 icmp_seq=1 ttl=59 time=2.154 ms
84 bytes from 192.168.10.10 icmp_seq=2 ttl=59 time=2.269 ms
84 bytes from 192.168.10.10 icmp_seq=3 ttl=59 time=2.394 ms
84 bytes from 192.168.10.10 icmp_seq=4 ttl=59 time=4.190 ms
84 bytes from 192.168.10.10 icmp_seq=5 ttl=59 time=3.189 ms
```

Actual CLI output - PC3

```
PC3> ping 192.168.10.10
84 bytes from 192.168.10.10 icmp_seq=1 ttl=59 time=4.158 ms
84 bytes from 192.168.10.10 icmp_seq=2 ttl=59 time=2.233 ms
84 bytes from 192.168.10.10 icmp_seq=3 ttl=59 time=1.904 ms
84 bytes from 192.168.10.10 icmp_seq=4 ttl=59 time=1.839 ms
84 bytes from 192.168.10.10 icmp_seq=5 ttl=59 time=1.858 ms
```

Actual CLI output - PC3

```
PC3> ping 192.168.20.10
84 bytes from 192.168.20.10 icmp_seq=1 ttl=61 time=1.628 ms
84 bytes from 192.168.20.10 icmp_seq=2 ttl=61 time=1.787 ms
84 bytes from 192.168.20.10 icmp_seq=3 ttl=61 time=1.910 ms
84 bytes from 192.168.20.10 icmp_seq=4 ttl=61 time=1.931 ms
84 bytes from 192.168.20.10 icmp_seq=5 ttl=61 time=1.456 ms
```

Actual CLI output - PC3

```
PC3> ping 192.168.20.10
84 bytes from 192.168.20.10 icmp_seq=1 ttl=61 time=1.951 ms
84 bytes from 192.168.20.10 icmp_seq=2 ttl=61 time=2.065 ms
84 bytes from 192.168.20.10 icmp_seq=3 ttl=61 time=1.678 ms
84 bytes from 192.168.20.10 icmp_seq=4 ttl=61 time=2.861 ms
84 bytes from 192.168.20.10 icmp_seq=5 ttl=61 time=1.612 ms
```

Actual CLI output - PC3

```
PC3> trace 192.168.10.10
trace to 192.168.10.10, 8 hops max, press Ctrl+C to stop
 1   192.168.30.1   0.576 ms  0.340 ms  0.281 ms
 2   10.45.45.1   1.042 ms  0.731 ms  1.043 ms
 3   10.34.34.1   0.794 ms  0.874 ms  1.039 ms
 4   10.23.23.1   2.074 ms  1.208 ms  1.287 ms
 5   10.12.12.1   1.452 ms  1.297 ms  1.265 ms
 6   *192.168.10.10   1.796 ms (ICMP type:3, code:3, Destination port unreachable)
```

WARNING - VPCS replies with UDP port-unreachable at the destination; this normally ends the trace.

14.1 Controlled BranchA maintenance

From the verified healthy state, shut only R2 Ethernet0/0, the Area10 connection to R1. This single branch has no alternate uplink. PC1 loses remote service and its loopback/LAN routes must disappear outside the branch. R2-R3-R4-R5 backbone/BranchB adjacencies and PC2-to-PC3 service must remain healthy. Do not modify other interfaces.

R2

```
enable
conf t
interface Ethernet0/0
shutdown
end
```

Wait at least 60 seconds, then verify the required state.

14.2 Prove isolation R2

Confirm the BranchA route is absent while surviving adjacencies and the BranchB path remain. Expected withdrawal is a yellow maintenance observation, not an unexpected error. Any loss of HQ-to-BranchB service is a failed isolation requirement.

R2

```
enable
terminal length 0
show ip ospf neighbor
show ip route 192.168.10.0
show ip route 192.168.30.0
```

Actual CLI output - R2

```
R2# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
3.3.3.3           0   FULL/  -        00:00:36    10.23.23.2      Ethernet0/1
```

Actual CLI output - R2

```
R2# show ip route 192.168.10.0
% Network not in table
```

WARNING - Branch A is deliberately disconnected; this loss is the intended maintenance impact.

Actual CLI output - R2

```
R2# show ip route 192.168.30.0
Routing entry for 192.168.30.0/24
  Known via "ospf 10", distance 110, metric 40, type inter area
  Last update from 10.23.23.2 on Ethernet0/1, 00:03:17 ago
  Routing Descriptor Blocks:
  * 10.23.23.2, from 4.4.4.4, 00:03:17 ago, via Ethernet0/1
      Route metric is 40, traffic share count is 1
```

14.3 Prove isolation R3

Confirm the BranchA route is absent while surviving adjacencies and the BranchB path remain. Expected withdrawal is a yellow maintenance observation, not an unexpected error. Any loss of HQ-to-BranchB service is a failed isolation requirement.

R3

```
enable
terminal length 0
show ip ospf neighbor
show ip route 192.168.10.0
show ip route 192.168.30.0
```

Actual CLI output - R3

```
R3# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
4.4.4.4           0   FULL/  -        00:00:39    10.34.34.2      Ethernet0/1
2.2.2.2           0   FULL/  -        00:00:37    10.23.23.1      Ethernet0/0
```

Actual CLI output - R3

```
R3# show ip route 192.168.10.0
% Network not in table
```

WARNING - Branch A is deliberately disconnected; this loss is the intended maintenance impact.

Actual CLI output - R3

```
R3# show ip route 192.168.30.0
Routing entry for 192.168.30.0/24
  Known via "ospf 10", distance 110, metric 30, type inter area
  Last update from 10.34.34.2 on Ethernet0/1, 00:03:17 ago
  Routing Descriptor Blocks:
  * 10.34.34.2, from 4.4.4.4, 00:03:17 ago, via Ethernet0/1
      Route metric is 30, traffic share count is 1
```

14.4 Prove isolation R4

Confirm the BranchA route is absent while surviving adjacencies and the BranchB path remain. Expected withdrawal is a yellow maintenance observation, not an unexpected error. Any loss of HQ-to-BranchB service is a failed isolation requirement.

R4

```
enable
terminal length 0
show ip ospf neighbor
show ip route 192.168.10.0
show ip route 192.168.30.0
```

Actual CLI output - R4

```
R4# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
3.3.3.3           0   FULL/  -        00:00:35    10.34.34.1      Ethernet0/0
5.5.5.5           0   FULL/  -        00:00:31    10.45.45.2      Ethernet0/1
```

Actual CLI output - R4

```
R4# show ip route 192.168.10.0
% Network not in table
```

WARNING - Branch A is deliberately disconnected; this loss is the intended maintenance impact.

Actual CLI output - R4

```
R4# show ip route 192.168.30.0
Routing entry for 192.168.30.0/24
  Known via "ospf 10", distance 110, metric 20, type intra area
  Last update from 10.45.45.2 on Ethernet0/1, 00:03:17 ago
  Routing Descriptor Blocks:
  * 10.45.45.2, from 5.5.5.5, 00:03:17 ago, via Ethernet0/1
      Route metric is 20, traffic share count is 1
```

14.5 Prove isolation R5

Confirm the BranchA route is absent while surviving adjacencies and the BranchB path remain. Expected withdrawal is a yellow maintenance observation, not an unexpected error. Any loss of HQ-to-BranchB service is a failed isolation requirement.

R5

```
enable
terminal length 0
show ip ospf neighbor
show ip route 192.168.10.0
show ip route 192.168.30.0
```

Actual CLI output - R5

```
R5# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
4.4.4.4           0   FULL/  -        00:00:38    10.45.45.1      Ethernet0/0
```

Actual CLI output - R5

```
R5# show ip route 192.168.10.0
% Network not in table
```

WARNING - Branch A is deliberately disconnected; this loss is the intended maintenance impact.

Actual CLI output - R5

```
R5# show ip route 192.168.30.0
Routing entry for 192.168.30.0/24, 2 known subnets
  Attached (2 connections)
  Variably subnetted with 2 masks
C        192.168.30.0/24 is directly connected, Ethernet0/1
L        192.168.30.1/32 is directly connected, Ethernet0/1
```

14.6 Prove BranchA impact PC1

Remote ping must fail from the intentionally isolated branch; the local gateway remains reachable.

PC1

```
ping 192.168.10.1
ping 192.168.30.10
```

Actual CLI output - PC1

```
PC1> ping 192.168.10.1
84 bytes from 192.168.10.1 icmp_seq=1 ttl=255 time=0.423 ms
84 bytes from 192.168.10.1 icmp_seq=2 ttl=255 time=0.625 ms
84 bytes from 192.168.10.1 icmp_seq=3 ttl=255 time=0.575 ms
84 bytes from 192.168.10.1 icmp_seq=4 ttl=255 time=0.560 ms
84 bytes from 192.168.10.1 icmp_seq=5 ttl=255 time=0.556 ms
```

Actual CLI output - PC1

```
PC1> ping 192.168.30.10
*192.168.10.1 icmp_seq=1 ttl=255 time=0.892 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.10.1 icmp_seq=2 ttl=255 time=0.659 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.10.1 icmp_seq=3 ttl=255 time=0.726 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.10.1 icmp_seq=4 ttl=255 time=0.693 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.10.1 icmp_seq=5 ttl=255 time=0.632 ms (ICMP type:3, code:1, Destination host unreachable)
```

WARNING - Branch A is deliberately disconnected; this loss is the intended maintenance impact.

14.7 Prove unaffected HQ service PC2

HQ to BranchB must still return all five replies during the BranchA disconnect.

PC2

```
ping 192.168.30.10
ping 192.168.30.10
```

Actual CLI output - PC2

```
PC2> ping 192.168.30.10
84 bytes from 192.168.30.10 icmp_seq=1 ttl=61 time=1.492 ms
84 bytes from 192.168.30.10 icmp_seq=2 ttl=61 time=1.950 ms
84 bytes from 192.168.30.10 icmp_seq=3 ttl=61 time=1.283 ms
84 bytes from 192.168.30.10 icmp_seq=4 ttl=61 time=1.684 ms
84 bytes from 192.168.30.10 icmp_seq=5 ttl=61 time=1.373 ms
```

Actual CLI output - PC2

```
PC2> ping 192.168.30.10
84 bytes from 192.168.30.10 icmp_seq=1 ttl=61 time=3.223 ms
84 bytes from 192.168.30.10 icmp_seq=2 ttl=61 time=2.352 ms
84 bytes from 192.168.30.10 icmp_seq=3 ttl=61 time=2.716 ms
84 bytes from 192.168.30.10 icmp_seq=4 ttl=61 time=4.029 ms
84 bytes from 192.168.30.10 icmp_seq=5 ttl=61 time=2.008 ms
```

14.8 Prove unaffected reverse service PC3

BranchB to HQ must still return all five replies during the BranchA disconnect.

PC3

```
ping 192.168.20.10
ping 192.168.20.10
```

Actual CLI output - PC3

```
PC3> ping 192.168.20.10
84 bytes from 192.168.20.10 icmp_seq=1 ttl=61 time=1.458 ms
84 bytes from 192.168.20.10 icmp_seq=2 ttl=61 time=2.899 ms
84 bytes from 192.168.20.10 icmp_seq=3 ttl=61 time=1.921 ms
84 bytes from 192.168.20.10 icmp_seq=4 ttl=61 time=2.241 ms
84 bytes from 192.168.20.10 icmp_seq=5 ttl=61 time=2.459 ms
```

Actual CLI output - PC3

```
PC3> ping 192.168.20.10
84 bytes from 192.168.20.10 icmp_seq=1 ttl=61 time=1.874 ms
84 bytes from 192.168.20.10 icmp_seq=2 ttl=61 time=3.969 ms
84 bytes from 192.168.20.10 icmp_seq=3 ttl=61 time=1.627 ms
84 bytes from 192.168.20.10 icmp_seq=4 ttl=61 time=1.891 ms
84 bytes from 192.168.20.10 icmp_seq=5 ttl=61 time=1.743 ms
```

15.1 Restore only the BranchA transit

Re-enable R2 Ethernet0/0 without changing the approved area, cost or passive policy. Wait for adjacency synchronization and route installation; then repeat the full forwarding regression.

R2

```
enable
conf t
interface Ethernet0/0
no shutdown
end
```

Wait at least 60 seconds, then verify the required state.

16.1 Final router regression R1

Verify required FULL neighbors and all four remote loopbacks from Loopback0. Every final probe must return five replies; these twenty directed tests also validate return paths.

R1

```
enable
terminal length 0
show ip ospf neighbor
show ip route ospf
ping 2.2.2.2 source Loopback0
ping 3.3.3.3 source Loopback0
ping 4.4.4.4 source Loopback0
ping 5.5.5.5 source Loopback0
```

Actual CLI output - R1

```
R1# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
2.2.2.2           0   FULL/  -        00:00:38    10.12.12.2      Ethernet0/0
```

Actual CLI output - R1

```
R1# show ip route ospf
Gateway of last resort is not set
      2.0.0.0/32 is subnetted, 1 subnets
O IA     2.2.2.2 [110/11] via 10.12.12.2, 00:00:53, Ethernet0/0
      3.0.0.0/32 is subnetted, 1 subnets
O IA     3.3.3.3 [110/21] via 10.12.12.2, 00:00:53, Ethernet0/0
      4.0.0.0/32 is subnetted, 1 subnets
O IA     4.4.4.4 [110/31] via 10.12.12.2, 00:00:53, Ethernet0/0
      5.0.0.0/32 is subnetted, 1 subnets
O IA     5.5.5.5 [110/41] via 10.12.12.2, 00:00:53, Ethernet0/0
      10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
O IA     10.23.23.0/30 [110/20] via 10.12.12.2, 00:00:53, Ethernet0/0
O IA     10.34.34.0/30 [110/30] via 10.12.12.2, 00:00:53, Ethernet0/0
O IA     10.45.45.0/30 [110/40] via 10.12.12.2, 00:00:53, Ethernet0/0
O IA  192.168.20.0/24 [110/30] via 10.12.12.2, 00:00:53, Ethernet0/0
O IA  192.168.30.0/24 [110/50] via 10.12.12.2, 00:00:53, Ethernet0/0
```

Actual CLI output - R1

```
R1# ping 2.2.2.2 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
Packet sent with a source address of 1.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

Actual CLI output - R1

```
R1# ping 3.3.3.3 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
Packet sent with a source address of 1.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

Actual CLI output - R1

```
R1# ping 4.4.4.4 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
Packet sent with a source address of 1.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 2/2/3 ms
```

Actual CLI output - R1

```
R1# ping 5.5.5.5 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 5.5.5.5, timeout is 2 seconds:
Packet sent with a source address of 1.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 2/5/15 ms
```

16.2 Final router regression R2

Verify required FULL neighbors and all four remote loopbacks from Loopback0. Every final probe must return five replies; these twenty directed tests also validate return paths.

R2

```
enable
terminal length 0
show ip ospf neighbor
show ip route ospf
ping 1.1.1.1 source Loopback0
ping 3.3.3.3 source Loopback0
ping 4.4.4.4 source Loopback0
ping 5.5.5.5 source Loopback0
```

Actual CLI output - R2

```
R2# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
3.3.3.3           0   FULL/  -        00:00:35    10.23.23.2      Ethernet0/1
1.1.1.1           0   FULL/  -        00:00:32    10.12.12.1      Ethernet0/0
```

Actual CLI output - R2

```
R2# show ip route ospf
Gateway of last resort is not set
      1.0.0.0/32 is subnetted, 1 subnets
O        1.1.1.1 [110/11] via 10.12.12.1, 00:00:53, Ethernet0/0
      3.0.0.0/32 is subnetted, 1 subnets
O        3.3.3.3 [110/11] via 10.23.23.2, 00:00:58, Ethernet0/1
      4.0.0.0/32 is subnetted, 1 subnets
O        4.4.4.4 [110/21] via 10.23.23.2, 00:00:58, Ethernet0/1
      5.0.0.0/32 is subnetted, 1 subnets
O IA     5.5.5.5 [110/31] via 10.23.23.2, 00:00:58, Ethernet0/1
      10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O        10.34.34.0/30 [110/20] via 10.23.23.2, 00:00:58, Ethernet0/1
O IA     10.45.45.0/30 [110/30] via 10.23.23.2, 00:00:58, Ethernet0/1
O     192.168.10.0/24 [110/20] via 10.12.12.1, 00:00:53, Ethernet0/0
O     192.168.20.0/24 [110/20] via 10.23.23.2, 00:00:58, Ethernet0/1
O IA  192.168.30.0/24 [110/40] via 10.23.23.2, 00:00:58, Ethernet0/1
```

Actual CLI output - R2

```
R2# ping 1.1.1.1 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1.1.1.1, timeout is 2 seconds:
Packet sent with a source address of 2.2.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

Actual CLI output - R2

```
R2# ping 3.3.3.3 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
Packet sent with a source address of 2.2.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

Actual CLI output - R2

```
R2# ping 4.4.4.4 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
Packet sent with a source address of 2.2.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 2/2/2 ms
```

Actual CLI output - R2

```
R2# ping 5.5.5.5 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 5.5.5.5, timeout is 2 seconds:
Packet sent with a source address of 2.2.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/3 ms
```

16.3 Final router regression R3

Verify required FULL neighbors and all four remote loopbacks from Loopback0. Every final probe must return five replies; these twenty directed tests also validate return paths.

R3

```
enable
terminal length 0
show ip ospf neighbor
show ip route ospf
ping 1.1.1.1 source Loopback0
ping 2.2.2.2 source Loopback0
ping 4.4.4.4 source Loopback0
ping 5.5.5.5 source Loopback0
```

Actual CLI output - R3

```
R3# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
4.4.4.4           0   FULL/  -        00:00:38    10.34.34.2      Ethernet0/1
2.2.2.2           0   FULL/  -        00:00:37    10.23.23.1      Ethernet0/0
```

Actual CLI output - R3

```
R3# show ip route ospf
Gateway of last resort is not set
      1.0.0.0/32 is subnetted, 1 subnets
O IA     1.1.1.1 [110/21] via 10.23.23.1, 00:00:54, Ethernet0/0
      2.0.0.0/32 is subnetted, 1 subnets
O        2.2.2.2 [110/11] via 10.23.23.1, 00:04:59, Ethernet0/0
      4.0.0.0/32 is subnetted, 1 subnets
O        4.4.4.4 [110/11] via 10.34.34.2, 00:04:56, Ethernet0/1
      5.0.0.0/32 is subnetted, 1 subnets
O IA     5.5.5.5 [110/21] via 10.34.34.2, 00:04:53, Ethernet0/1
      10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O IA     10.12.12.0/30 [110/20] via 10.23.23.1, 00:00:59, Ethernet0/0
O IA     10.45.45.0/30 [110/20] via 10.34.34.2, 00:04:56, Ethernet0/1
O IA  192.168.10.0/24 [110/30] via 10.23.23.1, 00:00:54, Ethernet0/0
O IA  192.168.30.0/24 [110/30] via 10.34.34.2, 00:04:53, Ethernet0/1
```

Actual CLI output - R3

```
R3# ping 1.1.1.1 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1.1.1.1, timeout is 2 seconds:
Packet sent with a source address of 3.3.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

Actual CLI output - R3

```
R3# ping 2.2.2.2 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
Packet sent with a source address of 3.3.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Actual CLI output - R3

```
R3# ping 4.4.4.4 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
Packet sent with a source address of 3.3.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Actual CLI output - R3

```
R3# ping 5.5.5.5 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 5.5.5.5, timeout is 2 seconds:
Packet sent with a source address of 3.3.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

16.4 Final router regression R4

Verify required FULL neighbors and all four remote loopbacks from Loopback0. Every final probe must return five replies; these twenty directed tests also validate return paths.

R4

```
enable
terminal length 0
show ip ospf neighbor
show ip route ospf
ping 1.1.1.1 source Loopback0
ping 2.2.2.2 source Loopback0
ping 3.3.3.3 source Loopback0
ping 5.5.5.5 source Loopback0
```

Actual CLI output - R4

```
R4# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
3.3.3.3           0   FULL/  -        00:00:33    10.34.34.1      Ethernet0/0
5.5.5.5           0   FULL/  -        00:00:38    10.45.45.2      Ethernet0/1
```

Actual CLI output - R4

```
R4# show ip route ospf
Gateway of last resort is not set
      1.0.0.0/32 is subnetted, 1 subnets
O IA     1.1.1.1 [110/31] via 10.34.34.1, 00:00:55, Ethernet0/0
      2.0.0.0/32 is subnetted, 1 subnets
O        2.2.2.2 [110/21] via 10.34.34.1, 00:04:57, Ethernet0/0
      3.0.0.0/32 is subnetted, 1 subnets
O        3.3.3.3 [110/11] via 10.34.34.1, 00:04:57, Ethernet0/0
      5.0.0.0/32 is subnetted, 1 subnets
O        5.5.5.5 [110/11] via 10.45.45.2, 00:04:54, Ethernet0/1
      10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O IA     10.12.12.0/30 [110/30] via 10.34.34.1, 00:01:00, Ethernet0/0
O        10.23.23.0/30 [110/20] via 10.34.34.1, 00:04:57, Ethernet0/0
O IA  192.168.10.0/24 [110/40] via 10.34.34.1, 00:00:55, Ethernet0/0
O     192.168.20.0/24 [110/20] via 10.34.34.1, 00:04:57, Ethernet0/0
O     192.168.30.0/24 [110/20] via 10.45.45.2, 00:04:53, Ethernet0/1
```

Actual CLI output - R4

```
R4# ping 1.1.1.1 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1.1.1.1, timeout is 2 seconds:
Packet sent with a source address of 4.4.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 2/2/3 ms
```

Actual CLI output - R4

```
R4# ping 2.2.2.2 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
Packet sent with a source address of 4.4.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

Actual CLI output - R4

```
R4# ping 3.3.3.3 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
Packet sent with a source address of 4.4.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Actual CLI output - R4

```
R4# ping 5.5.5.5 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 5.5.5.5, timeout is 2 seconds:
Packet sent with a source address of 4.4.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

16.5 Final router regression R5

Verify required FULL neighbors and all four remote loopbacks from Loopback0. Every final probe must return five replies; these twenty directed tests also validate return paths.

R5

```
enable
terminal length 0
show ip ospf neighbor
show ip route ospf
ping 1.1.1.1 source Loopback0
ping 2.2.2.2 source Loopback0
ping 3.3.3.3 source Loopback0
ping 4.4.4.4 source Loopback0
```

Actual CLI output - R5

```
R5# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
4.4.4.4           0   FULL/  -        00:00:35    10.45.45.1      Ethernet0/0
```

Actual CLI output - R5

```
R5# show ip route ospf
Gateway of last resort is not set
      1.0.0.0/32 is subnetted, 1 subnets
O IA     1.1.1.1 [110/41] via 10.45.45.1, 00:00:56, Ethernet0/0
      2.0.0.0/32 is subnetted, 1 subnets
O IA     2.2.2.2 [110/31] via 10.45.45.1, 00:04:55, Ethernet0/0
      3.0.0.0/32 is subnetted, 1 subnets
O IA     3.3.3.3 [110/21] via 10.45.45.1, 00:04:55, Ethernet0/0
      4.0.0.0/32 is subnetted, 1 subnets
O IA     4.4.4.4 [110/11] via 10.45.45.1, 00:04:55, Ethernet0/0
      10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
O IA     10.12.12.0/30 [110/40] via 10.45.45.1, 00:01:01, Ethernet0/0
O IA     10.23.23.0/30 [110/30] via 10.45.45.1, 00:04:55, Ethernet0/0
O IA     10.34.34.0/30 [110/20] via 10.45.45.1, 00:04:55, Ethernet0/0
O IA  192.168.10.0/24 [110/50] via 10.45.45.1, 00:00:56, Ethernet0/0
O IA  192.168.20.0/24 [110/30] via 10.45.45.1, 00:04:55, Ethernet0/0
```

Actual CLI output - R5

```
R5# ping 1.1.1.1 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1.1.1.1, timeout is 2 seconds:
Packet sent with a source address of 5.5.5.5
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

Actual CLI output - R5

```
R5# ping 2.2.2.2 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
Packet sent with a source address of 5.5.5.5
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

Actual CLI output - R5

```
R5# ping 3.3.3.3 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
Packet sent with a source address of 5.5.5.5
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Actual CLI output - R5

```
R5# ping 4.4.4.4 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
Packet sent with a source address of 5.5.5.5
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

16.6 Final client regression PC1

Check the stored name/address and require five replies from each remote client after recovery.

PC1

```
show ip
ping 192.168.20.10
ping 192.168.30.10
```

Actual CLI output - PC1

```
PC1> show ip
NAME        : PC1[1]
IP/MASK     : 192.168.10.10/24
GATEWAY     : 192.168.10.1
MAC         : 00:50:79:66:68:06
LPORT       : 20000
RHOST:PORT  : 127.0.0.1:30000
MTU         : 1500
```

Actual CLI output - PC1

```
PC1> ping 192.168.20.10
84 bytes from 192.168.20.10 icmp_seq=1 ttl=61 time=1.790 ms
84 bytes from 192.168.20.10 icmp_seq=2 ttl=61 time=1.772 ms
84 bytes from 192.168.20.10 icmp_seq=3 ttl=61 time=2.840 ms
84 bytes from 192.168.20.10 icmp_seq=4 ttl=61 time=2.934 ms
84 bytes from 192.168.20.10 icmp_seq=5 ttl=61 time=1.021 ms
```

Actual CLI output - PC1

```
PC1> ping 192.168.30.10
84 bytes from 192.168.30.10 icmp_seq=1 ttl=59 time=2.657 ms
84 bytes from 192.168.30.10 icmp_seq=2 ttl=59 time=2.667 ms
84 bytes from 192.168.30.10 icmp_seq=3 ttl=59 time=2.195 ms
84 bytes from 192.168.30.10 icmp_seq=4 ttl=59 time=2.039 ms
84 bytes from 192.168.30.10 icmp_seq=5 ttl=59 time=2.225 ms
```

16.7 Final client regression PC2

Check the stored name/address and require five replies from each remote client after recovery.

PC2

```
show ip
ping 192.168.10.10
ping 192.168.30.10
```

Actual CLI output - PC2

```
PC2> show ip
NAME        : PC2[1]
IP/MASK     : 192.168.20.10/24
GATEWAY     : 192.168.20.1
MAC         : 00:50:79:66:68:07
LPORT       : 20000
RHOST:PORT  : 127.0.0.1:30000
MTU         : 1500
```

Actual CLI output - PC2

```
PC2> ping 192.168.10.10
84 bytes from 192.168.10.10 icmp_seq=1 ttl=61 time=2.980 ms
84 bytes from 192.168.10.10 icmp_seq=2 ttl=61 time=1.860 ms
84 bytes from 192.168.10.10 icmp_seq=3 ttl=61 time=1.477 ms
84 bytes from 192.168.10.10 icmp_seq=4 ttl=61 time=1.722 ms
84 bytes from 192.168.10.10 icmp_seq=5 ttl=61 time=1.667 ms
```

Actual CLI output - PC2

```
PC2> ping 192.168.30.10
84 bytes from 192.168.30.10 icmp_seq=1 ttl=61 time=1.387 ms
84 bytes from 192.168.30.10 icmp_seq=2 ttl=61 time=1.595 ms
84 bytes from 192.168.30.10 icmp_seq=3 ttl=61 time=1.542 ms
84 bytes from 192.168.30.10 icmp_seq=4 ttl=61 time=1.453 ms
84 bytes from 192.168.30.10 icmp_seq=5 ttl=61 time=2.808 ms
```

16.8 Final client regression PC3

Check the stored name/address and require five replies from each remote client after recovery.

PC3

```
show ip
ping 192.168.10.10
ping 192.168.20.10
```

Actual CLI output - PC3

```
PC3> show ip
NAME        : PC3[1]
IP/MASK     : 192.168.30.10/24
GATEWAY     : 192.168.30.1
MAC         : 00:50:79:66:68:08
LPORT       : 20000
RHOST:PORT  : 127.0.0.1:30000
MTU         : 1500
```

Actual CLI output - PC3

```
PC3> ping 192.168.10.10
84 bytes from 192.168.10.10 icmp_seq=1 ttl=59 time=1.905 ms
84 bytes from 192.168.10.10 icmp_seq=2 ttl=59 time=3.700 ms
84 bytes from 192.168.10.10 icmp_seq=3 ttl=59 time=3.051 ms
84 bytes from 192.168.10.10 icmp_seq=4 ttl=59 time=2.023 ms
84 bytes from 192.168.10.10 icmp_seq=5 ttl=59 time=3.984 ms
```

Actual CLI output - PC3

```
PC3> ping 192.168.20.10
84 bytes from 192.168.20.10 icmp_seq=1 ttl=61 time=1.417 ms
84 bytes from 192.168.20.10 icmp_seq=2 ttl=61 time=1.300 ms
84 bytes from 192.168.20.10 icmp_seq=3 ttl=61 time=2.843 ms
84 bytes from 192.168.20.10 icmp_seq=4 ttl=61 time=2.569 ms
84 bytes from 192.168.20.10 icmp_seq=5 ttl=61 time=1.771 ms
```

17.1 Save verified R1

Persist only the verified healthy state. The delivered complete save-config must independently boot and pass read-only verification.

R1

```
enable
write memory
```

Actual CLI output - R1

```
R1# write memory
Building configuration...
[OK]
```

17.2 Save verified R2

Persist only the verified healthy state. The delivered complete save-config must independently boot and pass read-only verification.

R2

```
enable
write memory
```

Actual CLI output - R2

```
R2# write memory
Building configuration...
[OK]
```

17.3 Save verified R3

Persist only the verified healthy state. The delivered complete save-config must independently boot and pass read-only verification.

R3

```
enable
write memory
```

Actual CLI output - R3

```
R3# write memory
Building configuration...
[OK]
```

17.4 Save verified R4

Persist only the verified healthy state. The delivered complete save-config must independently boot and pass read-only verification.

R4

```
enable
write memory
```

Actual CLI output - R4

```
R4# write memory
Building configuration...
[OK]
```

17.5 Save verified R5

Persist only the verified healthy state. The delivered complete save-config must independently boot and pass read-only verification.

R5

```
enable
write memory
```

Actual CLI output - R5

```
R5# write memory
Building configuration...
[OK]
```

17.6 Save verified PC1

Persist only the verified healthy state. The delivered complete save-config must independently boot and pass read-only verification.

PC1

```
save
```

Actual CLI output - PC1

```
PC1> save
Saving startup configuration to startup.vpc
.  done
```

17.7 Save verified PC2

Persist only the verified healthy state. The delivered complete save-config must independently boot and pass read-only verification.

PC2

```
save
```

Actual CLI output - PC2

```
PC2> save
Saving startup configuration to startup.vpc
.  done
```

17.8 Save verified PC3

Persist only the verified healthy state. The delivered complete save-config must independently boot and pass read-only verification.

PC3

```
save
```

Actual CLI output - PC3

```
PC3> save
Saving startup configuration to startup.vpc
.  done
```

18. Common mistakes and diagnostic reasoning

If local forwarding fails, inspect addressing and interface state first. If a required neighbor is absent, compare interface area, timers, network type and passive policy on that link. If FULL is present but a LAN route is missing, verify the LAN interface is enabled in the correct OSPF area and inspect Type3 advertisements at both ABRs. If a Type1 LSA from a remote area is absent in the local LSDB, that can be expected area scoping. An absent local OSPF table entry for a directly connected subnet is also expected: its route is connected. Do not introduce undocumented faults into this guided exercise.

19. Key takeaways and interview review

Explain the role of Area0, overlapping ABR/backbone router classifications, Type1 scope versus Type3 propagation, the distinction between O IA and external routes, and the need for both route and client evidence. Explain why a Type3 Summary LSA can advertise an unchanged /24. Reconstruct the BranchB prefix path from R5 through R4 and R2 to R1. State what the maintenance test proved and which services were required to survive.

20. Final validation record

PASS: RAW and IP workflows, controlled Branch A isolation/recovery, and independent save-config cold boot were executed live on the approved IOL image. No configuration was entered during the complete-state cold boot.

Gate	Result
RAW factory boot and complete ordered workbook workflow	PASS
IP starting-state workflow with no preconfigured OSPF	PASS
Required FULL neighbors and ABR / area classifications	PASS
Intra-area / inter-area routes, costs and next hops	PASS
Type3 origin, area, mask, metric and Router LSA scope	PASS
Six directed client paths and twenty loopback paths	PASS
Branch A isolation preserves HQ / Branch B service	PASS
Restoration and complete forwarding regression	PASS
Complete save-config cold boot without configuration entry	PASS
Identical topology, approved images and explicit PC names	PASS

Validation scope: exact approved IOL L3 image on the pilot EVE-NG. All CLI excerpts come from the RAW exercise stage stated above. Timers, LSA ages, sequence numbers and timings may vary. Selected LSDB detail is omitted only when unrelated to the objective. RAW and IP workflows, isolation/recovery and a separate no-configuration cold boot of save-config were executed.

References: Cisco ENARSI v1.1 blueprint; Cisco OSPF Areas and Virtual Links.